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COSMOLOGY.

AN

ENQUIRY

Into the Cauſe of what is called

Gravitation or Attraction,

IN WHICH THE

MOTIONS OF THE HEAVENLY BODIES,

AND THE

Preſervation and Operations

OF ALL NATURE,

ARE DEDUCED FROM AN

Univerſal Principle of EFFLUX and REFLUX.

With COPPER PLATES.

By T. VIVIAN, *Vicar of Cornwood, Devon.*

Looks through Nature up to Nature's God.

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ADVERTISEMENT.

THE greateſt part of the following eſſay was publiſhed a year ſince. As the Author's manner of treating the ſubject led him into what an eminent Critick† ſtiles *devious ways*, he finds he was not always underſtood. Therefore to make his meaning clear, he has added ſome plates, with explanations of them, together with anſwers to ſome objections.

BRITISH MUSEUM

Some apology may be thought neceſſary

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† Critical Review, July 1792.

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18

ceſſary, for preſuming to differ from names of the higheſt authority, in ſuch an important point, as the principle of the univerſe. And this apology the Author wiſhes to make, and propoſes his opinion with all proper deference and reſpect. He is fully ſatisfied of the truth of the principles advanced, and thinks he has produced ſuch proofs as ſome perſons will admit as fairly concluſive. In fact this already appears to be the opinion of ſome that were zealous advocates for the eſtabliſhed doctrines. But he knows mankind too well to expect to ſee the leaders of the public opinion in philoſophy change their language. A few of the younger ſtudents may be leſs reſtrained by prejudice, and, guided by their own enlightened minds may, by ſuggeſting truths connected with theſe, and perhaps correcting ſome miſtakes, improve the preſent ſketch into a regular ſyſtem of Coſmology, founded on intelligible principles. For this eſſay pretends to nothing more than laying a foundation for others to build on; or rather ſtrengthening the building already erected.

There is in this city (Bath) a magnificent range of ſuperb edifices, remaining in the ſame unfiniſhed ſtate they were in almoſt a year ago: which is owing to the ground ſliding off in front, and preſſing on behind the building. To prevent a fall of the whole ſtructure, they are now making arches under ground. The preſent eſſay has been conſidered as ſerving a ſimilar end to the Newtonian ſyſtem, by the Author of the following lines in the Gentleman's Magazine for January 1792.

Great Newton's ſyſtem hung on ſpeculation,
This baſe ſupplied, reſts on a firm foundation.

BATH,
March 26, 1792.

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ERRATA.

P. 22, line 24, read, and *with* a degree
25, for contracting, read *counteracting*
87, line 15, for his, read *its*
88, line 6, for deductions, read *proofs*
92, line 10, read *unneceſſary*
93, line 23, for the, read *an*
117, line 15, omit artificial
158, line 17, for opens with a, read *flows into the*

COSMOLOGY.

COSMOLOGY, &c.

The Introduction, in which the different notions of Gravitation are ſtated.

THE Heavens declare the glory of God; and the Earth is full of his riches. In them we have convincing evidence of the almighty power, wiſdom, and goodneſs of HIM that formed them, and directs their motions. And a ſenſe of theſe perfections in the GREAT CREATOR, has a tendency to fill the ſoul with awful reverence, gratitude, and love.

COSMOLOGY then, (or an acount of the univerſe) is a very uſeful ſcience. And they are benefactors to mankind, who help us ſo to read this book of the viſible Heavens;

vens; the Earth and its productions; as to diſcover more clearly the divine perfections there diſplayed, than we could do without their aſſiſtance.

Among theſe the moſt diſtinguiſhed is Sir *Iſaac Newton.* He hath traced out an univerſal law by which the heavenly orbs move round the Sun, and heavy bodies fall towards the Earth. This is the law of what is called GRAVITATION, or ATTRACTION.

But it has been aſked, What is Gravitation; or Attraction? Are theſe *cauſes* or *effects?* If cauſes, how do they act? If effects, how are they produced? Some chooſe to call them *powers.* If ſo, in what bodies do theſe powers dwell? In the bodies attracting, or in the bodies attracted? An anſwer to theſe queſtions is the ſubject of the preſent *enquiry.*

By *Gravitation* is generally meant, 'a 'tendency in any body towards another body at a diſtance.' But how is ſuch a tendency poſſible in a body totally inanimate? If it is moved by ſome viſible agent, then Gravitation is not any power or quality inherent in the body. If it moves in obedience to a given command; this ſuppoſes a ſenſe of the command; and this ſenſe, or conſciouſneſs, to be reſiding in every part of the body; for every particle gravitates.

By *Attraction* is commonly meant a power, inherent in bodies, of drawing towards them other bodies at a diſtance. But how can any body act where it is not? How can the Sun regulate the motion of the Earth at the diſtance of ninety-five millions of miles? and the Georgian Planet at nineteen hundred millions of miles diſtance?

Almighty Power is equal to any poſſible effect; and Almighty Power is here employed: But in the ordinary courſe of nature we do not obſerve the power of the Almighty acting without the agency of ſecondary cauſes. 'We have never found,' (as one* well obſerves) 'a ſingle inſtance 'in the world of an end to be anſwered, 'without a ſuitable mean to accompliſh 'that end.' To Divine Agency all muſt ultimately be referred; but it is the buſineſs of philoſophy to trace out the inferior agents, which GOD is pleaſed to employ.

If in this enquiry we move cautiouſly, in dependence on Divine Aſſiſtance; the

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* Jeſſe's Lectures.

works will lead us to the GREAT CREATOR. But if we raſhly follow vain fancies, of ourſelves or others, we muſt loſe our way. 'Hence,' (ſays the Lord Preſident *Forbes*) 'ſo many *Coſmogonias*; ſo many 'ſyſtems to ſhew how the various *phænomena* are performed. Some ſet out on 'hypotheſis which time has diſcovered to 'be abſolutely falſe. Some gave only 'words which had no certain meaning; 'but which the philoſopher and his followers were perfectly ſatisfied with.'

The antient philoſophers reckoned attraction among the *occult qualities;* when they called it 'a native inclination in bodies to 'be in their proper ſphere or place.'

Copernicus ſtiles it 'an endeavour in bodies to return to their whole, when ſeparated from it.'

Kepler aſcribes it to 'the magnetic attraction of the Earth.'

Des Cartes ſpeaks more intelligibly when he calls it 'an external agency, or impulſe, 'or truſion of ſome ſubtil matter.' But he becomes as obſcure as the reſt, when he aſcribes this truſion to 'the rotation of 'the Earth; which makes all bodies en-

'deavour

‘ to recede; but they cannot, becauſe there ‘ is no vacuum.’ For in this caſe, all bodies would be preſſed upwards and downwards; but gravity (in bodies near the Earth) is always downwards.

Dr. Halley is content to aſcribe it ‘ to ‘ the agency of the Almighty,’ unable to diſcover the inferior agents, or ſecondary cauſes. So does Dr. Graveſende, who excludes all other cauſes.

Rohault ſays,—‘ Philoſophers have ‘ thought it poſſible to account for all the ‘ motions in nature by impulſe alone; for ‘ this is the only way that we can conceive ‘ clearly that one body moves another, ‘ by puſhing it. *Attraction, ſympathy, anti-‘ pathy, fear of vacuum, &c.* are mere chi-‘ meras. They ought not to be allowed at ‘ all.’ *Syſtem,* p. 1. ch. ii.

On this paſſage Dr. Clark’s commentary is as follows: ‘ *Attraction* and *ſympathy* and ‘ all *occult cauſes,* which are ſuppoſed to ‘ ariſe from the ſpecific forms of things, are ‘ juſtly to be rejected. Yet ſuch attraction ‘ muſt be allowed as is not the action of ‘ matter at a diſtance, but the action of ‘ ſome immaterial cauſe.’

Dr. Clark then cites Sir Iſaac Newton as ſpeaking thus: ‘ Have not the ſmall ‘ particles of bodies certain powers where-‘ by they act at a diſtance? What I call ‘ *attraction* may be performed by impulſe, ‘ (not bodily impulſe) or by ſome other ‘ means unknown to me.’ Newton's Opt. p. 350.

‘ To tell us that every ſpecies of things ‘ is endowed with an occult ſpecific quality, ‘ by which it acts, and produces manifeſt ‘ effects, is to tell us nothing. But to de-‘ rive two or three general principles of ‘ motion from phænomena, would be a ‘ very great ſtep to philoſophy, though the ‘ cauſes of theſe principles were not at all ‘ diſcovered. And therefore I ſcruple not ‘ to propoſe the principles of motion above ‘ mentioned, they being of very general ‘ extent; and leave their cauſes to be ‘ found out.’ Id. ibid.

If by *acting at a diſtance* Sir Iſaac Newton means acting without impulſe, it will not be eaſy to vindicate him from the cenſure he caſts on others that talk of *occult qualities*. By *acting at a diſtance* we might ſuppoſe he means impulſe communicated from a diſtance (as we ſay a gun kills at a diſtance)—But he adds *not bodily impulſe.*

By this expreſſion, and his adding the words, *or by ſome other means to me unknown* —he appears diſſatisfied with his diſcoveries on this ſubject.

Dr. Cotes thinks gravity 'a primary 'eſſential quality of matter.' But this Sir Iſaac Newton diſclaims, on account of the pernicious conſequences, which ſome philoſophers drew from it. He makes himſelf a nearer approach to what is probably the truth, when he ſhews, that 'there is in 'nature a medium vaſtly more ſubtil than 'air; by which light is reflected and ſound 'communicated; and which he ſuppoſes 'may be more rare towards the Sun, and 'cauſe gravitation by preſſing towards it. 'If,' ſays he, 'the elaſtic force of this me'dium be exceeding great, it may ſuffice 'to impel bodies towards the rarer parts 'by what we call *gravity*.' And this elaſticity he proves to be exceeding great by its vibrations in ſound and light.

Theſe diſcoveries are very ingenious, but were not ſatisfactory to that great man himſelf. Therefore in his later writings he does not mean by attraction 'any *power* 'or *cauſe* at all; but an *effect* of ſome un'known power.' Nat. Prin. Math. Lib. i. p. 5.

CHAP. I.

Containing the propoſition which is the ſubject of this inquiry, with the inſtance of a burning lamp.

SIR Iſaac Newton ſeems to have diſcovered, in the elaſtic force of the ætherial fluid, and the greater rarity towards the Sun, a ſufficient cauſe of conſtant preſſure to conſtitute a centripetal force; but he had not diſcovered how the æther, thus accumulated toward the Sun, could be diſperſed again: ſo as to conſtitute a conſtant rotation of centrifugal and centripetal powers.

This is the deſign of the preſent inquiry; in which it is not meant to oppoſe any part of his ſyſtem; but to eſtabliſh and compleat it, by proving and illuſtrating the following propoſition:

"There is in the Sun and planets, the
"Earth, and probably all the parts of it,
"(while in their natural ſtate) a power or
"principle, by which they emit continually, and receive or abſorb a proportional quantity of fluid matter: by
"which efflux and reflux their being is
"preſerved, and their various motions and
"operations performed."

This active principle is *Fire*, which pervades all nature, either in a latent or perceivable ſtate. And where it is thus active, it ſtrikes different ſenſes, being ſeen in light, or felt in heat, or both ſeen and felt in burning.

A *lamp* or common candle may be ſeen at the diſtance of two miles. But whereever it can be ſeen, there are a quantity of rays ſufficient to paint the image of the lamp on the optick nerve. And as we approach the lamp the rays (or corpuſcules of matter iſſuing from the flame) grow denſer, inverſely as the ſquare of the diſtances.

Here then is a ſphere of light iſſuing from a common candle of four miles diameter, of different denſity; but in the leaſt denſe part ſufficient to fill this large ſpace with rays of light, ſo far that a needle's point cannot be placed without being covered with ſo many of them as are ſufficient to cauſe viſion: for the candle may be ſeen through a hole one fiftieth of an inch in diameter. And this vaſt ſphere of light is renewed every inſtant: by computation two hundred thouſand times in every ſecond of time: ſuppoſing it flies as ſwiftly as the light of the Sun.

To ſupply this large expence of light, we are told by them that have made the experiment, that a common candle conſumes a gallon of atmoſpherical air in a minute: that is, a gallon of air is every minute ſo changed, by the burning of the candle, as to produce rays of light ſufficient to fill a ſpace four miles in diameter.

CHAP. II.

The ſame propoſition applied to the Sun.

FROM a common lamp on Earth let us aſcend to the great lamp of Heaven, the *Sun.*

Here we have an immenſe body, diffuſing every inſtant its light to an immenſe diſtance. In ſeven or eight minutes the Sun pours forth a ſphere of light reaching to the Earth, and in a few minutes more to the newly diſcovered planet.

But this is not the extent of the ſolar light. Wherever the Sun can be ſeen by the beſt eye, with the help of the beſt glaſs that can be formed, thither (at leaſt) muſt his light extend. If, as is generally and with good reaſon believed, the fixed ſtars are ſuns, our Sun (being of the ſame nature) muſt be viſible as far as they are ſeen, If his ſize and brightneſs are equal to the ſize and brightneſs of a ſtar of the third or fourth magnitude, his light muſt reach to, at leaſt, one half of the fixed ſtars diſcovered by Mr. Herſchell; and how far that is I leave him to compute.

How ſhall this vaſt expence of light be recruited? Here the burning lamp may direct us. It is a ſun in miniature. The body of the Sun correſponds to that ſmall flame; the diſtance of the fixed ſtars to the ſphere four miles in diameter; the ſolar rays to the light of the lamp; and the ætherial reflux to the part of the atmoſpherical air neceſſary to feed the flame. Æther (that *elaſtick medium* of Sir Iſaac Newton, and *ſubtil matter* of Des Cartes, and perhaps what Dr. Clark meant by his *immaterial body* capable of impulſe by truſion) is but a purer air, as the ſolar light is a purer fire.

Here then we have a ſolar efflux and reflux, correſponding and proportioned to each other; meeting yet not interfering, as the effluent light and refluent air of a common lamp. Here (in this ætherial reflux) is that centripetal power, ſo much ſought after by *the Great Philoſopher;* and which he believed equal to the effect; but had not diſcovered any conſtant cauſe to produce its continual direction towards the

Sun, the want of which diſcovery has been ſupplied by the word *attraction.* Here too (in the emanation of the ſolar rays) we have a direct centrifugal force counterbalancing the other; which that *great man* ſupplied from the direction originally impreſſed on the planet, by the hand of *the Almighty.*

In order to examine this important ſubject diſtinctly, and ſhew not only the poſſibility, but great probability of it; 'that 'all the planets are kept and moved in their 'orbits by this conſtant efflux of light, and 'reflux of an ætherial fluid to reſtore the 'equilibrium.'—It will be neceſſary to eſtimate firſt, the acting *power*, ſecondly, the *effect* to be produced, thirdly, the *application* of the power to the object, and then ſhew how far this theory correſponds with acknowledged *facts.*

I. The *acting power* in the centrifugal force is the ſolar rays.

That theſe have a conſiderable impetus may be known from our own experience. When the Sun's rays fall on the ſkin, and eſpecially when they ſtrike the eye, we feel the ſtroke very ſenſibly, when the tender parts are not ſkreened: for which kind office the eyelids are provided by the wiſe and benevolent CREATOR.

The reality and degree of this power is further aſcertained by a variety of experiments. All theſe are limited to the ſurface of the Earth, but we ſhall hereafter ſee reaſons to conclude that the ſolar rays pervade the whole body of the Earth and other planets, and in this way exert their wonderful efficacy, in guiding the heavenly bodies, and various other operations; as the moſt active powers in nature.

What is here ſaid of the rays of light, conſidered as the centrifugal force, keeping the planets at a due diſtance from the Sun, is equally applicable to the ætherial reflux acting as the centripetal power, by preſſing towards the Sun. In fact this ætherial reflux which moves towards the Sun (correſponding to the pure or inflammable air ſpoken of as ruſhing into the burning lamp) may be the ſame luminous fluid that iſſues from the Sun; now diveſted of its light and heat, but retaining its ſubtil penetrating nature. It may be the *ſame*, (or an *equivalent*) elaſtick fluid, reſtoring by its elaſticity the equilibrium, deſtroyed by the conſtant emanation of the ſolar rays.

II. From this view of the *power* let us proceed to examine the *effect* to be produced; that we may judge whether the former is equal to the latter.

This effect is the motion of the planet in its orbit. And what obſtacle is there to this motion? The *vis inertiæ* in bodies near the Earth is conſiderable indeed, and owing to a cauſe we ſhall hereafter inquire into. But in the heavenly bodies this reſiſtance is merely imaginary. A perſon of judgment and penetration (though accuſtomed to the old phraſeology of attraction) owned very candidly, that if the planets moved in empty ſpace, (*in vacuo*) a man's hand would be ſufficient to move the largeſt of them; and for this plain reaſon, becauſe there would be no reſiſtance.

But the planets (it is generally allowed) do not move in empty ſpace. The vaſt regions of the viſible Heavens are not unoccupied. We ſee there light diffuſed throughout; and probably there are many other bodies of a ſubtil nature. Theſe compoſe what is ſtiled the *æther* or *ætherial fluid;* which in ſubtilty may as far exceed our atmoſphere, as this does the ocean; or as much as this laſt in denſity comes ſhort of the Earth.

Yet though the æther be extremely ſubtil, ſome reſiſtance it muſt make to bodies moving with ſo ſwift a motion as the planets, and of ſo large a ſize. And this reſiſtance (and this only) is the obſtacle to be removed by the impelling powers, of the ſolar efflux and ætherial reflux, impinging on different ſides.

It is generally ſuppoſed (and with great reaſon) that all the planets were originally moved by the hand of Him that formed them, giving them a proper direction and proper force, which together ſhape the orbit in which they move. But they are kept in their orbits (inſtead of going off in a direct line) by the combined powers of the ſolar rays and ætherial reflux. Theſe ſubordinate agents keep the planet in a curve and impel it round the Sun. And when we conſider the number and velocity of the ſolar rays (conſtituting the centrifugal force;) and the correſponding force of the refluent æther, ſupplying the vacuity occaſioned by the emiſſion of the ſolar rays (which reflux is the centripetal force;) and when we compare theſe forces with the extreme ſubtilty of the æther in which the planets move,—There is no reaſon to ſuſpect that theſe united powers are not fully adequate to the effect aſcribed to them;

that is, the regulation of the planet's motion in its orbit, with a velocity proportioned to the moving powers, and the reſiſtance of the medium.

But it ſhould never be forgotten, that the original and continual Agent is God himſelf. Theſe centrifugal and centripetal powers ſo wiſely contrived, are but the fingers of the Almighty; by which He ſuſtains and guides the work of his hands: and without whoſe continual help, all life and motion in Heaven and Earth, are as impoſſible, as it was, by any power in the creature, to produce life and motion at the firſt.

III. But though the *power* be in itſelf adequate to the effect to be produced; it is neceſſary to be further aſſured of the *application of the power to the* object: that it *reaches* the body in a manner and direction proper to produce the effect.

That the ſolar rays reach the Earth we have ocular proof, but it is not ſo clear that they penetrate the Earth, ſo as to reach every particle of matter contained in it. It has been ſaid; ‘ No rays penetrate ‘ far below the ſurface that we know of.’ And ‘ Few bodies afford a paſſage to the ‘ rays of light.’

In anſwer to theſe objections (which may be very generally made) it may be obſerved in the firſt place, that if the ſolar rays *do* penetrate, it will be impoſſible to *ſee* that they do ſo. Our not ſeeing them therefore in the bowels of the Earth is no proof that they are not there.

But the ſolar rays are diſcoverable not only by their light, but by their heat: the Sun being, in the opinion of the beſt philoſophers, the ſole fountain of light and heat. It will hence follow that where there is heat or light, thither the Sun's rays penetrate. But there is a degree of heat in the loweſt parts of the Earth that have yet been diſcovered, and there is no reaſon to ſuſpect but a like heat pervades the whole. Of courſe the ſolar rays (as warm though not luminous) pervade every part of the Earth alſo.

But let us attend to actual obſervation ſo far as that can be obtained, with reſpect to the *minuteneſs* of the ſolar rays, the *poroſity* of the Earth, and the actual *proofs* of their penetrating.

We are told by an accurate Collector of philoſophical diſcoveries, that 'the focus 'of a burning mirror, which augments the

'denſity of the Sun's rays upwards of three
'thouſand times, may be received in the
'bodies of glaſs and water without produc-
'ing any viſible effect. So far are the
'particles of thoſe ſubſtances from imped-
'ing the paſſage of light.' *Nicholſon's Introduction to Natural Philoſophy.*

If the rays of light are ſo ſmall that they penetrate the pores of glaſs even when multiplied three thouſand times, can it be poſſible that the Earth or any part of it can obſtruct their entrance, in the ſtate they reach the Earth, when they are three thouſand times leſs compact; and of courſe meet with a proportional leſs obſtruction.

But it may be ſaid, the Earth is not ſo porous as glaſs. The difference is not great, as appears from their reſpective weight: but the pores of the Earth are not in ſo ſtrait a direction as thoſe of glaſs or clear water. This circumſtance makes a difference with reſpect to viſion; for to produce this a pencil of rays muſt return from the object to the eye. It makes a difference alſo with reſpect to penetrating. The focal rays of the burning glaſs, obſtructed by the winding poroſity of the Earth and all opaque bodies burſt through with violence, and conſume with the ſtrongeſt fire we are acquainted with. But ſince the rays, as they fall on the Earth, diſcover no ſuch effect; we may well conclude from comparing their extreme minuteneſs with the poroſity of the Earth, that they penetrate the whole with eaſe. Indeed it is aſtoniſhing to conſider how great this poroſity of the Earth, and all bodies, has been found to be. The Author laſt cited ſays, that 'It is probable that the real matter in a ſmall piece of glaſs,' (and of courſe in any other body of the ſame ſize and weight) 'may bear a leſs proportion to its bulk, than that bulk does to the whole Earth.'

After this it may well be aſked, What is there to hinder the rays of light from penetrating every part of the Earth? Theſe, by reaſon of their extreme minuteneſs, their velocity, and conſtant impulſe muſt pervade the Earth, (and by parity of reaſon the other planets) more eaſily than water penetrates a ſieve, or fills a ſponge: more eaſily than air flies through a foreſt, yet ſtriking every tree and every leaf in it. In fact, no particle of matter can eſcape their conſtant impulſe. And the particles of refluent æther (which conſtitute the centripetal power in the ſyſtem meant to be eſtabliſhed) are probably equally penetrating and active.

The effect of theſe united powers muſt be, that the planets ſhall all move with velocity proportioned, not to their ſurfaces, but to the quantity of matter contained in them, (except ſo far as they are affected by their different diſtances from the Sun) for every particle is impelled. And this conſequence, which follows ſo neceſſarily from the preſent hypotheſis, has been demonſtrated, by the *Great Philoſopher*, to be the real fact. Which coincidence, of reaſoning and facts, is the ſtrongeſt proof of the truth of any ſyſtem.

IV. By theſe centripetal and centrifugal forces, balancing each other, the planet is prevented from flying off from the Sun, or falling into it. But how is it moved at all? or kept in motion by overcoming the reſiſting medium?

It was doubtleſs moved at firſt by the hand of HIM that formed it, in a direction, and a degree of force, exactly ſuitable to their contracting powers, and proper to keep it in its intended orbit. And for this continued preſervation the powers themſelves are wonderfully adapted.

The two powers are equal, but they do not ſtrike the planet in directions exactly oppoſite. The centripetal reflux moves directly towards the Sun; but the centrifugal rays in an inclined direction. This is owing to the Sun's motion round his axis from Eaſt to Weſt, in twenty-five days and ſix hours. Of courſe the rays emitted by him do not fall perpendicularly on the planet, but in a direction inclined towards the Eaſt. This is ſimilar to the direction of a ball ſhot perpendicularly upward from the deck, or at a right angle from the ſide of a ſhip under ſail. It partakes of the motion of the ſhip, and of the direction in which the piece is pointed; and that according to their reſpective velocities.

The conſequence of this inclined direction of the centrifugal force will be, that (while the centripetal reflux ſtriking exactly that ſide of the planet which is fartheſt from the Sun, moves it towards him with its whole impetus) the centrifugal power falls obliquely; in a line combined of two directions: of which one is ſtrait on from the Sun, the other inclined eaſtward. Of courſe the planet will be moved forward in its orbit by ſo much of the centrifugal 'impulſe, as this in its direction deviates from a perpendicular on the planet.

Hence it ariſes that though the two powers be equal in themſelves, yet one coming in a ſtrait direction, the other inclined towards the Eaſt; the centrifugal force does not operate ſo ſtrongly in keeping off the planet, as the centripetal power in impelling it to the Sun. And the conſequence would be that the planet would by degrees fall into the Sun. But this is prevented by the original impulſe from the CREATOR's hand. This has been eſteemed by Philoſophers as a ſufficient balance to the centripetal force of attraction; and forming in conjunction with it the planet's orbit. It may therefore certainly be admitted for our preſent purpoſe; as adequate to the regulation of the difference between the centripetal power of that part of the æther that preſſes towards the Sun, and the centrifugal force of the ſolar rays.

V. Another circumſtance proving this ſyſtem to be agreeable to a phænomenon very accurately traced by Sir Iſaac Newton, but the cauſe of which he expreſsly left to others to diſcover, is this: 'The 'ſolar rays continually diverging muſt be'come weaker in their effect, as they go 'further

‘ farther from the Sun; and that in a ratio ‘ inverſely proportioned to the ſquares of ‘ their diſtances.’ In this proportion therefore will planets at different diſtances from the Sun be impelled by the ſolar rays; except ſo far as depends on their different magnitudes.

The ſame will be the caſe with reſpect to the centripetal power of the reflux. As this preſſes towards the Sun in *converging rays*. Thoſe, coming from immenſe diſtances, but directed to one point, the Sun; muſt be in proportion to the *diverging rays* of the Sun, in every diſtance from it. Hence it is that theſe two powers are ſo nicely balanced at every diſtance, and their joint effect on different planets at different diſtances muſt correſpond to the ſquares of the diſtances.

When an effect ſo long and ſo univerſally admitted, as founded on experience, follows ſo neceſſarily from a given cauſe; there is all the reaſon, that the caſe will admit, to ſuppoſe that to be the real cauſe.

To this account of the ſolar rays and refluent æther, jointly cauſing the weight or gravity of all bodies on or near the Earth, it may be objected, that the cauſe does not exactly correſpond to the effect. 'The ſolar rays' (it may be ſaid) 'deſcend 'perpendicularly on that ſide of the Earth 'only which is neareſt to the Sun. On 'other parts they fall obliquely, and one 'half of the globe they do not reach at all. 'Of courſe if theſe were the cauſe of gra-'vity, the weight of bodies would vary in 'proportion to the denſity of the ſolar 'rays; and on a great part of the Earth 'bodies would have no weight at all.

This objection is plauſible and nothing more. For

I. The ſolar rays are not the *only* cauſe of gravity; but with them are joined, in producing this great effect, the ætherial reflux towards the Sun, and alſo the rays from the Moon and other bodies: (as will be ſhewn hereafter) eſpecially the conſtant equable impulſe of the fixed ſtars.

II. When the rays (of the Sun and Moon and other bodies) reach the atmoſphere, they are all *refracted*, and thus inclined to a perpendicular towards the Earth; by which means the effect is nearly the ſame as if they fell perpendicularly at firſt. And beſides refraction the Great Philoſopher diſcovered another change in the rays when they reached a denſer medium, which he calls *inflection*, their being bent by the reaction of bodies which they touched; or even without touching them, as is the caſe in *reflection*. By theſe the atmoſphere ſeems calculated to guide the rays of the Sun and other bodies to the Earth.

And here we have freſh cauſe to adore the Divine Wiſdom, in the final cauſe or end effected by theſe properties, refraction and inflection: By means of theſe, the rays that enter the atmoſphere in ſuch a direction as (if continued) would carry them wide of the Earth, ſo as never to reach it, are refracted and inflected in different degrees; according to the denſity of thoſe parts of the atmoſphere through which they paſs, and probably according to the ſize of the particles in the rays themſelves: For the ſeven colours are all refracted in different degrees. By this wonderful proviſion, the rays fall with an impulſe cauſing gravity on thoſe parts of the Earth where, by the different refractions and inflections, they do not cauſe light. And thus is anſwered that wonderful purpoſe of fixing all bodies, to the ſpheres to which they belong, by a chain ſtrong in proportion to their quantities of matter.

By this the atmoſphere and waters are kept from being thrown off by the Earth's diurnal motion. By this all bodies preſerve their reſpective gravities, aſcertained and diſtinguiſhed in a way wonderfully ſuited to the conveniencies of life.

In the ſame manner is produced the phænomenon of the tides, partly by the ſolar rays, but chiefly by thoſe of the Moon; by reaſon of her being much nearer the Earth; and therefore (except in articles of heat and illumination) acting with more power than the Sun.

Of the Moon's power over the ſeas we ſhall ſay ſomething more hereafter: at preſent, confining our remarks chiefly to the Sun's rays, from the foregoing theory the following effects may be expected:

I. The Sun will act on the waters on the Earth with an impulſe ſimilar to that with which it impreſſes other bodies.

II. When waters are equally preſſed they preſerve a level; but where they are leſs preſſed they will riſe higher, where more preſſed they will ſink lower, according to the different degrees of preſſure.

III. On the parts of the Earth neareſt the Sun, the rays falling denſer and uninterrupted, and in a direction entirely perpendicular, the waters will be kept down: partly by the impelling rays, and partly by the atmoſphere impelled by them. On other parts leſs preſſed, they will riſe.

IV. In every part of the Earth this variation of greateſt and leaſt preſſure changing round in every diurnal revolution will produce high water, and low water alternately, once in twenty-four hours: ſo far as the tides depend on the Sun.

V. The ætherial reflux towards the Sun (always equal to the efflux and acting on the oppoſite part of the Earth) will produce exactly the ſame effect as the efflux, that is another change of high and low water again, in the ſame ſpace of time.

VI. The Moon acts on the ſame principle, but with more force. When, as at New Moon, the Sun and Moon act together the effect is greateſt, producing a ſpring tide. When, as at Full Moon, the Moon acts with the refluent æther, the effect is the ſame. When, at the Quarters, the two luminaries counteract each other, the effect is in proportion to the Moon's power above that of the Sun.

With reſpect to the time when the effect is produced they that aſcribe it to *attraction* obſerve that ‘ the time of high water is not preciſely the time of the Moon's coming to the meridian, but about an hour or two after.’ And of the ſpring tides they obſerve, that ‘ they do not happen directly on the new and full Moons, but rather a day or two after; when the action of the Sun and Moon have conſpired together a conſiderable time.’

Now according to the preſent theory of impulſe inſtead of attraction, low water is the effect produced. And at what diſtance of time this effect will take place, after the cauſe begins to operate in full force, can be known only from obſervation. The real cauſe of impulſe will probably operate ſix hours after the imaginary cauſe of attraction was ſuppoſed to act; this being the time between high and low water.

No notice has yet been taken of the *diurnal* motion of the Earth and other planets round their axis.

This motion has been generally, and juſtly, aſcribed to the hand of the Cre-

ATOR. And if the planets moved in a *vacuum*, the original motion muſt have continued; as it could meet with no obſtruction. But they do not move in a *vacuum*. Light, we ſee, is diffuſed over the vaſt ſpaces in which the planets move, and the more diſtant regions between the fixed ſtars. But light is itſelf a body, having other qualities beſides that of being luminous. It has been ſhewn to be capable of giving an impulſe, and of courſe of giving obſtruction. And from that fullneſs, which occupies all ſpaces, that we are acquainted with, we may fairly conclude with the greateſt philoſophers, that the æther is furniſhed with other bodies beſides light: though we have no other means of being ſatisfied of this truth, but that of rational deduction.

It may then be aſked, What is it that enables the planet, revolving on its axis, to overcome the reſiſtance of the medium, to this diurnal motion? The anſwer is—This very reſiſting medium, in conſequence of the annual motion of the planet in its orbit, continues this diurnal motion which otherwiſe it would deſtroy.

If a body is floating down a ſtream, and impelled by the wind more ſtrongly on one ſide than on the other; ſo as to cauſe the floating body to preſs againſt the water more ſtrongly on *the leeward ſide, than on that on which the wind blows, the effect will be that the floating body will turn round itſelf. This is exactly the caſe of the planet in its annual and diurnal motions. The planet is the floating body or object impelled. The centrifugal efflux and centripetal reflux combined are the wind or impelling power. The æther, being, in proportion to its denſity, impelled itſelf by theſe combined powers, anſwers to the deſcending ſtream of water. But this ſame æther moving, with leſs velocity than the planet, in proportion as its particles of matter are fewer, in the ſame ſpace than thoſe of the planet.—In this reſpect the æther is the reſiſting medium. So the deſcending ſtream, in which a body floats faſter than the water moves, is both a reſiſting medium and aſſiſting power.

As in the ſuppoſed caſe of a buoyant body ſwimming in a ſtream, one ſide (that next the right hand bank) being impelled more ſtrongly by the wind preſſes on the water neareſt the left bank, and being kept by its original direction from touching the ſhore, will by this ſide preſſure be turned round itſelf—So the planet, (preſſed more powerfully

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* Æther here denotes, not the ætherial reflux, but the whole of that fluid in which the planets move.

powerfully by the direct centripetal, than by the indirect centrifugal force, and being kept from falling towards the ſun by the direction, in a tangent to the orbit, originally given) will, by this preſſure againſt that part of the reſiſting medium which is neareſt the Sun, be turned round itſelf in a direction correſponding to its annual motion: that is, from Weſt to Eaſt.

This may explain to us the reaſon why all the planets (both primary and ſecondary) move in the ſame direction from Weſt to Eaſt. The combined impelling powers (by reaſon of the Sun's motion round its axis) move in this direction every body on which they fall with a ſufficient impetus. Even the medium itſelf will be moved the ſame way, but very gently; in proportion as its denſity is leſs than that of the planet. If it were poſſible that the heavenly bodies could be moved by attraction, this might be in very different directions; from the Eaſt as well as from the Weſt. But as they all move in the ſame direction, this ſeems to ſuppoſe ſome powers univerſally operating. As a cauſe is aſſigned equal to the effect; ſo it ſeems fair to conclude it is the right cauſe; eſpecially as we ſee the ſame correſpondence between cauſe and effect in other inſtances.

Let

Let us now contemplate and adore the wiſdom, power and goodneſs of God, diſplayed in the viſible Heavens. In them *hath He ſet a tabernacle for the Sun;* and turns him round on his axis to be the firſt great moving power in the ſolar ſyſtem. From this centre of motion is poured forth a flood of light and heat: by which the planetary worlds and their various inhabitants are not only enlightened, comforted, and quickened into life; but the orbs themſelves are *guided* in the path appointed for them. This view of Creation has that ſimplicity that characteriſes all the works of GOD; a ſimplicity in the principle attended by an amazing variety, yet harmony and uniformity in the effects.

How juſt an emblem then is the Sun of Him that is the *image of the inviſible God,* the *Son* of Righteouſneſs ariſen *with healing under his wings;* the *true Light that enlighteneth every man that cometh into the world:* the Source of light and life to the moral and ſpiritual world, as the Sun is to the natural world!

Beſides the planets there are other bodies within the ſolar ſyſtem, and which for that reaſon may be ſuppoſed to be moved by the great ſource of the celeſtial motions. Theſe are the Comets: which move in a manner very different from the planets; and, if guided by the Sun, it muſt be on a different principle. But this is no objection to the principle we have been conſidering as applied to the planets; ſo far as it is ſupported by fact and experience.

The ſame power acts in a very different manner on different ſubjects, according to their different qualities and capacities. That the Sun hardens clay is no proof that it cannot ſoften wax. If the planets and comets differ in their natures, they will be differently affected by the ſolar rays.

This different effect on different bodies by the ſame power is very apparent in electrical experiments. Theſe may lead us to ſome conception of the operations of the ſolar rays on comets, as differing from their effect on the planets.

The electricians ſeem to be agreed that the Sun is the ſource of the electric fluid; that it is diffuſed over all nature; and that it is ſeen and felt by means of friction. All this is probably true of fire in general. Motion cannot create it, but accumulates it, ſo as to become viſible.

Among other appearances in electrical experiments, we perceive by the touch and ſight, a corporeal effluvium emitted from, and returning to the electric body. In this effluvium light bodies paſs and repaſs, in contrary directions, at the ſame time. We have here a double current in the ſame ſpace; like the light iſſuing from, and the air ruſhing into, a lamp or common fire: or like the ſolar rays and ætherial reflux paſſing in different directions, without any perceivable interference. Nay the ſame bodies go off in the effluent current, and come back again in a contrary direction till touching or coming near the electric body they fly off again.

This alternate approach and receſs are not only obſervable in light bodies, but in ſome of conſiderable ſpecific gravity; ſuch as ſands, which in fact are ſmall ſtones: and pendulous metal bodies, in the experiment of the ringing bells.

Some electric powers have taught us ſomething of the properties of the lightning: perhaps others may ſerve as a ſtep to catch a glimpſe of the Divine Wiſdom and power in the motions of the comets. The Sun, and comets, and their varied motions in oppoſite directions, through immenſe ſpaces, may bear the ſame relation to one another, as the electric globe, the pendulous metal balls, or floating ſands, and their different motions, with different degrees of velocity, in different directions alternately.

In its aphelion (or greateſt diſtance from the Sun) a comet reſembles an electrified body, when, repelled from the electrifier, it is ſaid to be loſing its electricity. It then begins to return towards the Sun, impelled, perhaps, by the refluent æther that is the centripetal force of the planets. This impelling power growing ſtronger in its approach to the Sun increaſes the velocity of the comets, like the increaſed quickneſs of the ſands as they approach the electric ball, or tube. When the comet comes very near the Sun, it receives an electric ſtroke, which ſends it off with a rapid motion, till it reaches its aphelion again. In receding thus the comet may be impelled by the ſolar rays, whoſe force leſſens as the ſquares of the diſtances increaſe, till their power is ſpent by the reſiſtance of the ætherial medium.

All this is ſubmitted as what poſſibly *may* be, and ſimilar to electrical phænomena. And if any perſon aſks, Why do not the ſolar-rays hinder the comet from approaching? Or, Why does not the refluent æther hinder it from retiring? To theſe queſtions an anſwer will be given, when a ſimilar queſtion is explained; Why, in electrical experiments, do the floating and pendulous bodies move alternately to and from the ſource of the electric fluid, without being hindered by the oppoſite current? Here are facts that bear a reſemblance to each other, but in both there is a myſtery, that has not yet been explained.

C H A P. III.

The ſame theory applied to the Moon.

HAVING examined a burning *lamp*, and then the *Sun*, to diſcover the principle which is the ſubject of the preſent inquiry; let us next deſcend to the *Moon;* and ſee if we can there diſcover 'this power, where-'by all bodies throw off a continual ema-'nation, and receive or abſorb a propor-'tional quantity of fluid matter: by which 'efflux and reflux their being is preſerved, 'and their various motions and operations 'performed.'

This part of the inquiry is more intricate than any other, and requires more attention to avoid obſcurity: becauſe the Moon is to be conſidered in a threefold view:

I. As a *planet*, and as ſuch the *object* of the centrifugal and centripetal powers of the Sun; in a manner ſimilar to that in which the connection between the Sun and the Earth has been already inveſtigated. But

II. The Moon has another ſource and centre of centrifugal and centripetal power, and that is the Earth: by which ſhe is guided in her monthly courſe, as ſhe is by the Sun in her annual revolution.

III. At preſent the Moon is to be conſidered as being herſelf a central ſource of centrifugal efflux, and the central object of centripetal influx. Of courſe in this ſection theſe words refer to her as the centre of theſe powers: from which the firſt proceeds, and to which the other tends.

I. That the Moon has a great emanation or efflux we ſee with our own eyes; and this muſt extend as far as ſhe can be ſeen. Now as our moon is probably of the ſame nature as the other ſatellites, ſhe may be ſeen as far as Saturn, or even the Georgian Planet; for their Moons are viſible to us. Indeed it is probable our Moon may be ſeen farther than they; becauſe as ſhe is nearer the Sun, the light reflected from her is ſtronger than the light from them.

What then is this large emanation from the Moon? Its light is found, by collecting it into the focus of a burning glaſs, to be a thouſand times leſs denſe than the direct rays of the Sun, *Watſon's Eſſays.* And when thus collected the lunar rays have little or no increaſe of heat. Yet in ſome things this lunar emanation has a more powerful effect than the rays of the Sun. Whence it appears that the Moon throws off ſomething more than it receives from the Sun. For the ſolar rays, reflected from the Moon to the Earth, are weakened in proportion to the ſquares of ſpaces they paſs through. In light and heat they are weakened even more than in this proportion. There muſt therefore be ſomething more than light in the lunar emanation.

Indeed the nature and force of the lunar efflux has not been accurately aſcertained. The Ancients aſcribed to it more powerful effects on the animals and vegetables of the Earth than the Moderns will allow. But theſe find by experiments that its power is very conſiderable. Plants are found to flouriſh better when expoſed to the lunar rays, fruits ripen, and the fleſh of animals putrify faſter in the ſame ſituation. The various diſeaſes of the human body have long been ſuppoſed to be influenced by the Moon's age, and one of them takes its name from this circumſtance. Though much of what has been ſaid on this ſubject may be conjectural; that the beginning, criſis, and relapſe in fevers, in ſeveral parts of the world, are influenced by the changes of the Moon, ſeems proved beyond all doubt. *See Dr. Jackſon's Letter to Dr. Simmons.*

Dr. Mead alſo mentions various diſeaſes in which the criſis regularly took place at the new or full Moon; ſuch as palſy, hæmorrhages, fits, ulcers, aſthma, epilepſy, madneſs. It is ſaid of Lord Bacon, that he fainted at the time of the eclipſes.

This lunar *efflux* is a conſtant emanation from the moon in all directions. There is alſo a conſtant *influx* from all parts towards the Moon. Theſe two correſpond to the centrifugal and centripetal forces of the Sun: and the exiſtence of this laſt may be thus proved.

As the lunar efflux is extended ſo far, and fills ſo great a ſphere with a fluid proceeding from it, luminous, but of a different nature from that emanation which it receives from the Sun; the Moon muſt, in time, have been exhauſted by ſo profuſe an effuſion, had not ſome proviſion been made to repleniſh it. This proviſion is the centripetal influx or reflux of the ætherial fluid (or ſuch parts of it as the Great Creator has appointed) by which the vacuity cauſed by the emanation is ſupplied, and an equilibrium conſtantly preſerved.

Theſe two powers (the centrifugal efflux from the Moon and the centripetal influx towards it) produce all the effects, which have been aſcribed to the Moon's attraction: in the ſame manner as the ſame two powers in the Sun have been ſhewn, in a plain intelligible way, to effect all that has been aſcribed to the Sun's attraction.

Now according to Sir Iſaac Newton's theory of the laws of attraction, which (conſidered as an account of an effect only not of a cauſe) is acknowledged to be very accurate; as the Earth attracts the Moon, ſo the Moon attracts the Earth: that is, in words expreſſive of conceivable ideas: the Moon has a centrifugal and centripetal power producing (in its ſphere) effects ſuitable to thoſe produced by the ſame powers in the Sun and in the Earth, which effects have been called *attraction*. Of courſe there muſt be this centripetal reflux to the Moon. Without this the reſpective ſituations of the Earth and the Moon cannot be accounted for. But admitting theſe cauſes, it would be expected from the theory, that their ſituations would be exactly ſuch as by experience we find they are.

Whether this centripetal influx or reflux, towards the Moon, acts on the ſame principle as that which feeds the Sun, moved by its own elaſtick power to a leſs reſiſting medium; or whether it may not be on the principle of the electric current; or whether theſe may not be united, or perhaps the ſame; are points not eaſily aſcertained.

The exiſtence and power of this lunar reflux appear from the effects produced by it in conjunction with the lunar efflux. Theſe (like thoſe of the Sun) may reaſonably be conſidered as co-operating cauſes in producing weight or gravity in the Earth's atmoſphere, and all bodies on the Earth's ſurface. Theſe alſo may fairly be proved to be (in conjunction with ſimilar powers of the Sun) the cauſes of the ebbing and flowing of the tides.

I. And firſt with reſpect to the weight of heavy bodies and the atmoſphere.—The lunar efflux, (like that of the Sun) impinging on the Earth, and on all things on and near it, muſt have an impelling power, in proportion to its own activity, and the quantity of matter in the bodies on which it falls. And as by that wonderful alteration of the ſolar rays expreſſed by refraction, they are all turned towards the Earth, a ſimilar effect may well be ſuppoſed to be produced in the lunar efflux. By which means it co-operates with that of the Sun in producing the weight or gravity of bodies.

II.* But this impulſe of the lunar rays cannot be exactly the ſame at all times and in all places: hence ariſes a variation in the tides, according as the waters of the ſea are impelled more or leſs.

In that part of the earth which is neareſt the Moon the lunar rays fall direct and with undiminiſhed force. Here of courſe the waters are kept lower than in thoſe parts of the Earth that are more remote; and where the lunar rays fall indirectly, in conſequence of being refracted on entering into the atmoſphere. In thoſe parts therefore the waters being leſs preſſed down, it will be high water; while in thoſe parts neareſt the Moon where the waters are more forcibly preſſed down, it will be low water. But as every part of the Earth, in the ſpace of a day, or one revolution round its axis, is thus by turns neareſt to, or fartheſt from the Moon; in this way is produced one tide in every day.

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* See a fuller account of the tides in the Appendix.

With reſpect to the other tide, in every twenty-four hours, it is produced in the ſame manner by the lunar reflux; or that returning flow of æther towards the Moon, by which the general equilibrium is reſtored. This reflux always acts in a direction oppoſite to the efflux, and with equal power. It has therefore (on the oppoſite ſide of the Earth) the ſame effect in producing the gravity of bodies, and preſſing on the atmoſphere and waters.

But though the waters of the ſea are affected *principally* by the efflux and reflux of the Moon by reaſon of her being near the Earth, they are alſo, in an inferior degree affected by the ſolar efflux and reflux; as has already been obſerved when ſpeaking of the powers of the Sun.

III. From the Sun and Earth proceeds an emanation towards the Moon, as well as in all other directions; and towards each of theſe (as to all other parts) returns a reflux from the Moon. She is alſo impelled by that general ætherial reflux towards the Sun. Theſe together conſtitute the oppoſite powers by which ſhe is guided in her orbit, in the ſame manner as the Sun guides all the planets: but with this difference, that the Moon has two powers that move her, the Sun in her annual, the Earth in her monthly courſe. And from their united influence proceeds that gently bending line that marks her path. In this are great variations both in direction and velocity; but every variation flows directly from the impulſe of theſe two powers, counterpoiſed by the centrifugal force towards them both, and regulated by the eaſtern inclination of the centripetal radii of both, in conſequence of their motion round their axis; the Sun in twenty-five days and ſix hours, the Earth in twenty-four hours.

CHAP. IV.

The ſame principle, of efflux and reflux applied to the Earth.

HAVING conſidered the phænomena of the Sun and Moon, that make it highly probable, that they have in them this principle which is the ſubject of the preſent inquiry; 'a continual emanation and refluent æther, by which (like the reſpiration of animals) their being is preſerved, and the operations of moving, or being moved, performed;' let us inquire whether this ſame principle is to be found in the *Earth*, conſidered as one object.

I. From the air, water, and fire, in the bowels of the Earth, and on its ſurface, ariſe vapours of infinitely various qualities, according to their different bodies, and their different combinations.

Some part of theſe vapours return quickly to the Earth in dews, condenſed by the cold of night. Other parts of this heterogeneous mixture aſcend higher, and compoſe the *atmoſphere.* Here they are again ſeparated, after a variety of operations, cauſed by the heat of the Sun, the activity of the wind, and various other powers, ariſing from the different qualities of the mixture.

The water deſcends in rain, unleſs changed to ſnow in the clouds, or into hail in its deſcent. The air is variouſly diſperſed, in gentle breezes or violent ſtorms, by its own elaſtic active nature; reſtoring the equilibrium, wherever, by differing degrees of heat or cold, or any other cauſe, it is deſtroyed. The fire when diſengaged, flies off in lightning, or aſcends more gently in the lambent flame of the aurora, or (probably) in part joins the ætherial fluid, and returns (changed in its properties) to the ſolar fountain from whence it came; and from whence it comes again, compoſing (part at leaſt of) that which in its emanation is the centrifugal, and its reflux the centripetal power, that guides the planetary orbs. From this ætherial fire too, is probably ſupplied the electric fluid, which in a greater or leſs degree, and in a great variety of qualities and appearances ſeems to pervade all nature.

By theſe various ſeparations the atmoſphere grows leſs denſe, as the diſtance from the Earth increaſes, and where it is ſo far expanded and diſengaged from groſſer parts as to have no ſenſible weight, there it is called æther.

But part of this emanation from the Earth goes more than a few miles from it, which is ſuppoſed to be the height of the atmoſphere. Going off (like all emanations) in diverging radii, the firſt great object it meets with is the Moon. The effect of this impulſe, and a correſponding reflux, in guiding her in her monthly courſe, have been conſidered already. But there muſt be other effects produced.

Could we conſult the inhabitants of the Moon, they would tell us, that the Earth is to them a Moon, much larger than the Moon appears to us; returning with liberal increaſe all the benefits received from this our neareſt neighbour. Perhaps they could tell us much of the effect of this great effulgence on their world; with reſpect to their animals and vegetables, diſeaſes and tides: ſimilar to the effects of the lunar emanation experienced by us.

It is more than probable, from analogy, that a bright emanation goes from the Earth far beyond the Moon; even ſo far as the lately diſcovered planet. For this, it ſeems, has moons that are viſible on Earth: though they reflect leſs of the ſolar light, and (being ſecondaries) are probably of an inferior magnitude to the Earth. Of courſe the Earth can be ſeen as far as they: and wherever it can be ſeen it fills the vaſt ſphere. It fills, in a ſenſe, but with different degrees of denſity, gradually leſſening, as the ſquares of the diſtances increaſe, from the loweſt part of the atmoſphere beyond the Georgian Planet. Even at this great diſtance the terreſtrial radii are ſufficiently denſe to conſtitute viſion, by painting the image of the Earth on the optic nerve, or its ſpreading branch the retina.

II. As the firſt object of the Earth's emanation is the Moon, ſo this is the laſt body met with, and penetrated by the refluent æther; which conſtituting the centripetal power, preſſes the Moon towards the Earth; and, if the Moon has ſeas, will raiſe her tides, in the ſame manner as the lunar reflux raiſes thoſe of our globe.

When this reflux of æther approaches the Earth it penetrates and impels the atmoſphere; as do the ſolar rays: with which as well as the lunar efflux, (and indeed the emanation from every viſible ſtar) this æther is now combined. Thus impelled towards the Earth, by theſe united powers, the atmoſphere reſiſts the impulſe by a reaction proportioned to the quantity of matter contained in it. And hence ariſes its weight or gravity, always in proportion to the particles contained in any given column, and nicely aſcertained by the barometer.

The ſame cauſe will produce the ſame effect on all bodies on or near the ſurface of the Earth. They are all preſſed by the impelling æther, and ſolar, lunar, planetary, and ſtellar rays: this impulſe conſtitutes their weight or gravity. Without this impulſe we cannot ſee any reaſon why heavy bodies ſhould fall towards the Earth, that is, why they ſhould be heavy at all. But by this wonderful power the different planets are kept at a proper diſtance from each other, and every thing belonging to each of them is confined to its reſpective planet, by a reſtraint more effectual than a wall of braſs. Every thing on Earth is preſſed towards it in proportion to the quantity of matter it contains: a law long ſince diſcovered, but the cauſe or principle unknown.

III. This ſame principle prevails, and (as far as we can ſee) the ſame effects follow in all the heavenly bodies. They gravitate (as it is called) according to the quantity of matter contained in them. And this is moſt probably cauſed by the ſame centrifugal and centripetal powers that we have been conſidering in the Earth and Moon. By this they are both connected and ſeparated. By this their different atmoſpheres are preſerved, as appendages to the reſpective bodies, inſtead of being diſſipated in their rapid courſe round the Sun. By this every part of every orb is confined to the whole.

With reſpect to their mutual action on one another, between the primary and ſecondary planets, what has been ſaid of the Earth may be applied to the former, and what has been ſaid of the Moon, to the latter: except ſo far as a neceſſary difference ariſes from their different magnitudes and diſtances.

Thus, for inſtance, Jupiter and Saturn have a greater influence over their ſatel-

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lites than the Earth has over the Moon: becauſe theſe planets are larger than the Earth, and their Moons are more diſtant from the Sun than our Moon. The emanation from any body will of courſe be in proportion to its ſize; and the centripetal reflux will be in proportion to the emanation: for it is that which ſupplies its place, and reſtores an equilibrium. Of courſe the influence of any body will be in proportion to its ſize, including other circumſtances. Where theſe are different the effect will not always be in proportion to the bulk.

IV. If the ſyſtem here maintained be true, another circumſtance, that might be expected to follow from it is this: As the emanations from the planets extend ſo far, in proportion to their ſize and diſtance; it might be expected, that when the larger planets approach each other their motions would be diſturbed. And the ſatellites might affect the motions of their primaries in ſome degree, by their emanations and reflux. And this appears from experience to be the caſe, with reſpect to both.

CHAP. V.

Of the animals, vegetables, and minerals.

AFTER conſidering the Earth as one *whole*, let us examine the different bodies with which it is furniſhed; and inquire whether the principle which is the object of our ſearch (an *effluent and refluent current*) may not be found in different orders of *animals*, *vegetables*, and *minerals*.

I. In the *animal* part of the creation every thing perſpires. The groſſer parts of their effluvia may be ſeen on the ſkin, condenſed from vapour into water by the cool air. Where the heat of the animal is great, the effluent vapour may be ſeen as a cloud riſing above it; eſpecially when the air is ſo cold as to condenſe it before it is diſperſed.

A rarer fluid (or perhaps the ſame in a more expanded ſtate) is thrown off to a greater diſtance, which eſcapes the eye, but affects another ſenſe. The ſagacious dog winds the game at a diſtance; and by uſe learns to diſtinguiſh the different kinds; nay diſcerns a difference in the effluvia of individuals of the ſame kind. This efflux is ſometimes abſorbed by other bodies, and that in ſuch plenty as to be thrown off continually from them again, ſeveral hours after the animal has left the place.

Whatever perſpires muſt *abſorb*, or be ſoon waſted away. This abſorption is farther proved by the increaſe of weight, after being immerged long in water. Indeed anatomiſts undertake to ſhew us the perſpiring and abſorbing veſſels: and when theſe ceaſe to do their office, diſeaſes quickly follow. And by theſe abſorbing pores medicines are taken in.

II. In the *vegetable* world alſo life depends on perſpiration.

Did vegetables not *perſpire* we ſhould be deprived of their fragrance: and by the ſame rule ſhould not have that uſeful warning given by the effluvia of noxious herbs. There is perhaps no vegetable but may be ſmelt at ſome diſtance, either by ourſelves or more ſagacious animals. Of courſe they all throw off an efflux.

Hence they ſtand in conſtant need of a ſupply, which is provided for them. The light and warmth, of the ſolar rays, and phlogiſtic air, are found to be neceſſary to the growth of plants: ſo that they languiſh and die, when deprived of either of theſe parts of their food.

And what they thus receive they return again, deprived indeed of its phlogiſton: but by this operation prepared for the ſupport of *animal* life. While, on the other hand, the emanation from animals (and even their groſſeſt excrementitious matter and the air impregnated with it) is by this wonderful intercourſe, between the animal and vegetable worlds, the moſt delicious food of the latter.

III. The *mineral* kingdom alſo has its efflux and reflux; a kind of life, as well as animals and vegetables, and ſupported by the ſame pabulum, the ſolar rays and air: at leaſt ſuch parts of the air, as are ſuited to the growth and nouriſhment of animals.

And that theſe in their way perſpire or breathe, we may be convinced by our own ſenſes. They diffuſe an emanation either ſulphureous or arſenical, or tainted by ſome other prevailing body. Even metals throw off an effluvium diſtinguiſhed by the ſmell (except perhaps the two that are characteriſed as *fixt* and *perfect*) by which they are waſted and diſſolved. But, in their natural mineraliſed ſtate, they ſeem to have a power of recruiting their exhauſted ſtrength. By this their life is preſerved; and they increaſe by a kind of vegetation ſuited to their different natures. In a word, a kind of life is to be perceived in all the works of GOD, and this life is ſupported in them all by a communication with the Sun, the fountain of all light and life; and in a way of reſpiration, by an efflux and influx variouſly modified according to their various natures.

C H A P. VI.

The various kinds of attractions (ſo called), accounted for, from the principle that is the ſubject of this inquiry.

FROM the view we have taken of the various works of God, and the uniform appearance of an active principle of emanation and influx in them all, ſo far as they are ſubject to our examination; we may account in a rational, intelligible way, for all thoſe phænomena that have been called *attractions*. For this term has been applied to many things not yet conſidered; indeed to all appearances that could not be accounted for.

I. The *planetary* attraction we have conſidered at large: and ſhewn that it may reaſonably be conceived to be effected by the ſolar rays acting as a centrifugal force, and balanced by the æther preſſing towards the Sun, to ſupply the vacuity cauſed by ſuch a large emiſſion of its rays. This reſluent æther is a direct centripetal power, keeping the planet in its orbit, in conjunction with the centrifugal rays; while the eaſtern direction of the rays (in conſequence of the Sun's motion round its axis) impels all the planets from Weſt to Eaſt. Here is no imaginary power acting at a diſtance, where it is not; but a plain combination of adequate cauſes, producing a natural effect: under the direction of unerring Wiſdom and almighty Power.

II. A ſecond ſpecies of *attraction*, of which much has been ſaid, and little underſtood, is the attraction of *gravity*. This is an imaginary power, by which all things were ſuppoſed to be *drawn* towards the Earth. But where this power lay, or how it was exerted, could never be underſtood.

But the ſame ſolar rays which, we know, do *reach* the Earth; and for which reaſons have been alledged to induce a belief, that they *penetrate* and *impel* it as a *whole*.—Theſe rays together with the emanations from the Moon and ſtars, muſt impel every part of the Earth, all bodies on its ſurface, and the atmoſphere. In this impulſe an adequate cauſe may be found, for the tendency of all things towards the Earth, which are near it. Every particle being impelled, the preſſure muſt be in proportion to the quantity of matter. This follows from the *theory*, and this has long been acknowledged to be the *fact*.

III. A third ſpecies of *attraction* has been called the attraction of *coheſion*. This is the imaginary cauſe that has been aſſigned for the coheſion of two bodies, and parts of the ſame body. But all this may eaſily be ſhewn to be the neceſſary effect of the preſſure of the atmoſphere, itſelf preſſed by the power that gives it, and all things, *weight*. Indeed by this preſſure of the atmoſphere all bodies would be compacted to a hardneſs ſuperior to that of flint, had they not been expanded by the internal air and fire, whoſe preſence ſupports their life. Hence ariſe two cauſes of coheſion: the firſt between the particles of the ſame body when the internal heat is greatly diminiſhed; the other between any two bodies whoſe ſurface are ſo applied to each other as to exclude the atmoſphere from coming between them: For then the atmoſpherical preſſure, being equal on all ſides and in all directions, will cauſe them to *adhere* as one body. And as this adhering (or coheſion) is effected by the atmoſphere, ſo this preſſure on the atmoſphere (it has been endeavoured to ſhew) is occaſioned by the combined emanations, from the Sun and Moon and other orbs, impelled towards the Earth, to ſupply the vacuity cauſed by the emanations, which (we ſee) ariſe from it.

IV. Nearly connected with this attraction of coheſion is that, to which is aſcribed the *aſcent of fluids in capillary tubes.* But in this there is no more attraction than in the other: it is merely the effect of the atmoſpherical preſſure, partly excluded.

If you invert a tea-cup on a ſaucer without any liquid in either, ſo that the atmoſphere has free acceſs between them; you may take it up again without any effort, more than is neceſſary to bear the weight of the cup. But if water is poured into the ſaucer ſo as to exclude the atmoſphere, you cannot take up the cup, without lifting part of the atmoſphere, preſſing on the top, but excluded from the bottom of the cup. And as you gently raiſe the cup, the water is driven up into it by the incumbent air.

In this caſe the water aſcends by reaſon of the preſſure within the cup being diminiſhed: for by raiſing the cup a little, the

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encloſed air is expanded, and weakened in proportion to its expanſion. If the preſſure be diminiſhed by any other means, the effect will be the ſame. In capillary tubes, in ſponges, ſugar, earth, and the like, water riſes above its level on this ſame principle. The atmoſphere has free acceſs without; but within its acceſs is not ſo free. And in this way bogs are formed on the tops of hills, to be the reſervoirs of water to ſupply the earth with ſprings in dry ſeaſons. When the moiſture is exhaled, and the internal air weakened, by expanding itſelf to ſupply the place of the aſcending moiſture (as in the experiment of the tea-cup;) the water below is preſſed up by the atmoſphere as in a lump of ſugar. The moiſture aſcends becauſe the atmoſpherical preſſure has freer acceſs below than above.

V. Beſides the different kinds of attractions already accounted for (on the principle of an univerſal efflux and reflux) there is another ſort, which may be diſtinguiſhed by the name of *general attraction.*

It is ſaid that ‘ all matter gravitates, and every particle towards every particle; inſomuch that if the Earth was to be divided into two parts, they would immedi-

‘ afely unite by the power of attraction; as ‘ we ſee any part ſeparated from the Earth ‘ immediately falls towards it.’

That all matter in all the planets as well as the Earth gravitates towards the Sun has been admitted, and explained as the effect of centripetal impulſe. And that all the bodies on or near the Earth fall towards it, has been explained by the ſame principle; a combined impulſe towards the Earth from the ſolar, lunar, planetary, and ſtellar emanations. But that every part of matter gravitates towards every other part, is a fancy formed without any proof.

The uſual argument brought to prove this ſtrange kind of *univerſal attraction*, is that of two corks ſwimming in a baſon of water; which approach each other and ſtick together.

But to whatever cauſe this is owing it cannot be to *general attraction*; and that for this plain reaſon. If this was the cauſe, it would operate on the corks out of the water as well as in the water, if they be at liberty to move freely. But if they be ſuſpended by a ſtring near each other, there they continue without the leaſt ſymptom of mutual attachment, or attraction.

If inſtead of ſuch light, you ſuſpend heavy bodies (ſuch as lead of one pound or an hundred weight) the effect is ſtill the ſame. And thus we ſee the two weights of a clock hang very quietly cloſe together, without any attempt to make a nearer approach. Indeed if it were otherwiſe, there could be no ſuch thing as a plumb line. When the maſon applies his plumb to a wall, if all bodies attracted in proportion to the quantity of matter, the lead would be drawn towards the wall, and more ſtrongly in proportion to the ſize of the building. The conſequence would be that no wall could be perpendicular, but all great buildings would be wider at top. The uſe of the plumb produces no ſuch effect; therefore no ſuch cauſe exiſts.

VI. A ſixth kind of attraction, ſometimes mentioned, is that which may be diſtinguiſhed by the name of *central attraction*. By this, bodies, on or near the ſurface of the Earth, are ſuppoſed to be attracted towards the centre, and, if not prevented would fall into it. But this kind of attraction is ſcarce conſiſtent with that laſt mentioned. If all bodies were attracted towards all other bodies, then all could not be attracted towards the centre only. If this were the caſe, it would be impoſſible to know it to be ſo.

According to the theory which we would ſupport, all bodies tend towards the Earth, and the impulſe is directed towards every part. If therefore a body were deſcending towards the centre, its velocity would be leſſened, (ſo far as depended on repeated impulſes) becauſe the deeper it deſcended, more parts would be left above it. Yet, notwithſtanding this diminution of the force of the impelling power, the velocity on the whole would ſtill increaſe, till the falling body reached the centre: becauſe till then more parts of the Earth would be below than above it.

VII. A ſeventh ſort of attraction has been diſtinguiſhed by the name of *elective attraction.* By which is meant ſuch an attachment between two bodies, as makes them unite in a manner different from that in which they unite with other bodies; and ſometimes ſo as to diſſolve one or both of them.

Among other effects produced by that emanation and influx (or that efflux and reflux) which is the ſubject of this inquiry, may be conſidered the preſervation, and occaſionally, the diſſolution of bodies: that is, ſuch a change in their ſtate as is neceſſary to make them unite with, and produce certain changes in, other bodies.

The direct effect of the emanation is ſometimes to keep other bodies at a diſtance. Thus the Sun exerts his centrifugal power; and thus many bodies keep off water, quickſilver, and other things, whoſe free acceſs, by penetrating, might deſtroy them. The effect of the influx is ſometimes the preſervation of the body, and ſometimes its deſtruction. This depends on the internal formation of the different bodies that approach each other. Their particles and pores are formed to penetrate with more or leſs eaſe. And this difference in the formation of their internal parts occaſions the *elective* attractions, as the different formation of the external parts occaſions a difference in the degree of *coheſion*.

VIII. *Electrical attraction* has been already conſidered, when ſpeaking of the comets.

However ſtrange ſome of the electrical appearances are, none of them prove ſuch an inexplicable thing as bodies acting where they are not. The electrical current penetrates bodies with eaſe, and at the ſame time *impels* them; as appears from the effects, both on the external ſurface and internal parts. We perceive alſo a current returning to the electrifying body. So that here we have all that is ſuppoſed, as neceſſary, to explain the great phænomena of the orbs revolving round the Sun, and their effects on each other. What we ſee in electrical experiments may exiſt in other parts of the creation, a penetrating efflux and reflux.

IX. There is one kind of attraction more which is frequently mentioned; that is, the *magnetical*.

Magnetiſm abounds with wonderful phænomena: but the greateſt wonders are thoſe that are added by the imaginations of ingenious men; attempting to account for what is, perhaps, unſearchable. Theſe tell us of attractions between all the magnets on Earth, and an imaginary loadſtone in, or near, the centre of the Earth. But if theſe attractions are effected by effluvia paſſing to and from the centre, this admits the poſſibility of ſuch penetrating, impelling powers as we have ſuppoſed. If this be an attraction without communication, it is an effect without a cauſe.

Experience tells us that the magnetical effluvia will penetrate with efflux and reflux ſimilar to that of electricity, and to the effluvia of the Sun, Moon, and planets through intervening bodies at a certain diſtance. We know too that the magnetical fluid goes off and returns in a direction ſuited to the poles of the Earth, and with an inclination below the horizon. The magnet too has a power of throwing off its effluvium, ſo as to impregnate a body lying near it, in a proper direction. But ſteel or iron are the only bodies capable of this impregnation: and theſe aſſume all the properties of the original magnet, and can communicate them to other pieces of the ſame metal. All this is agreeable to the ſyſtem of penetrating effluvia, but here is no proof of any body acting on another without a real communication.

If we would indulge the flights of imagination, we might ſuppoſe the pores of the loadſtone and of iron, particularly ſuited to receive and emit the magnetical effluvia, floating in the atmoſphere in a northern and inclined direction. However this be, we ſee cauſe to adore the Divine

Goodneſs in making this property of the magnet a means of opening a communication; between the moſt diſtant regions of the world.

Beſides theſe different kinds of *attraction*, *Repulſion* is ſometimes mentioned as a powerful cauſe, producing great effects.

That repulſion which implies a cauſe acting where it is not, without any connection between the repelling and repelled bodies, is as ill-founded a notion as the ſame kind of attraction. But there is a repulſion that is real, and affected by that emanation, which is found in bodies in general; but differing in its effects according to the different ſubjects in which it is found, and the different objects to which it is directed.

There is an electrical repulſion, by which electrified bodies keep off and drive others from them; when floating in the electric current. There is a magnetical repulſion, by which the magnetical efflux repels the needle applied to the wrong pole. There is a general repulſion whereby bodies keep off others that are not ſuited to them, the effect of the general efflux obſervable in bodies. By this repulſive power, perhaps, it is that light is reflected in part from bodies where in part it enters. By this water is repelled from the unctuous effluvium on the ſkins of animals. By this dry bodies keep off water, though floating in it. But this kind of repulſion is very eaſily conceived, and agrees with the general ſyſtem of an effluent and refluent current.

CON-

CONCLUSION.

IN reviewing what has been written in this inquiry, it ſeems fair to admit the following points as highly probable, though not ſtrictly ſpeaking demonſtrated.

I. Attraction or gravitation though admitted as a phænomenon or *effect*, and, as ſuch, reaſoned on with ſucceſs in inveſtigating its laws, cannot be admitted as a *cauſe*. In this light it was given up by the Great Philoſopher.

II. There is another power, of whoſe efficacy many eminent men have entertained an opinion, as equal to all the effects aſcribed to attraction; but they found obſtacles in purſuing their inquiries, which later diſcoveries have tended to remove.

III. This adequate power is the ſolar rays and the united emanations of all the heavenly bodies: together with that reflux, which ſuch a plentiful emanation makes neceſſary to reſtore an equilibrium.

IV. By the ſolar rays as the centrifugal force, and the correſponding centripetal power of the ætherial fluid, the planetary world is moved; and all the other effects produced which are commonly expreſſed by gravitation.

V. With reſpect to the reality of this power we have all the proofs which it would be poſſible to produce; if things really were as we have endeavoured to prove them to be.

VI. With reſpect to luminous bodies, we have ocular demonſtration of the reality of the emanation: and as to others, the different bodies on Earth, we have proof of their effluvia from another ſenſe.

VII. Where there is an efflux, there a reflux muſt be concluded to exiſt alſo, as neceſſary to preſerve the exiſtence of the different bodies. For a continual waſting, without a correſponding reparation, muſt in time deſtroy every thing.

VIII. In many inſtances this reflux may be diſcerned, or clearly diſcovered from the

effects:

effects: as in the burning lamp, the Sun, the Moon, and Earth, and many animals, and vegetables.

IX. As the ſolar efflux reaches the planets; ſo it has been ſhewn to be equal to the effect aſſigned to it: as the only obſtacle is the ſlight reſiſtance of the æther in which they move. By its direction eaſtward, and the counteracting centripetal power of the ætherial fluid (or ſuch part of it as is ſuited to be the *pabulum* of the ſolar fire) it appears wonderfully adapted to keep the orbs in their place, and move them in their orbits.

X. Beſides moving the planets and ſatellites in their orbits, and giving them light: the ſolar, lunar, earthly, ſtellar, and planetary emanations, by their joint influence, their velocity, minuteneſs, and activity have been proved to produce great effects in the animal and vegetable worlds; from the conſequences that follow when their influence is in any meaſure interrupted.

XI. There are equal reaſons to ſuppoſe that the mineral kingdom is equally affected by the ſame powerful agents; in the various metals, ſemi-metals, precious ſtones, and other productions: all which indicate the force of active agents under the direction of infinite Wiſdom.

XII. Theſe powers have been ſhewn to be equal to all the effects that have commonly been aſcribed to attractions of different ſorts.

In a mind properly diſpoſed this diſplay of the wiſdom, power, and goodneſs of God will excite admiration and gratitude, like that expreſſed by the Pſalmiſt: "O 'Lord, how manifold are thy works! In 'wiſdom haſt Thou made them all: the 'Earth is full of thy riches. So is the great 'and wide ſea.' Its numerous inhabitants are equally benefited by theſe powerful agents, through the bounty and goodneſs of *the Lord of life and glory.*

ANNOTATIONS

ON THE

ESSAY ON COSMOLOGY.

ANNOTATIONS.

P. 2. WHAT is *Gravitation or Attraction?*]—It is remarkable with rega to *attraction* (a word ſo often uſed to a count for things not underſtood) that perhaps, ſtrictly ſpeaking, there is no ſuch thing in all nature.

The aſcent of water in a pump was ſaid to be the effect of attraction, till the barometer ſhewed another principle. Still however in common language we hear of *drawing* water.

Other kinds of attraction are examined in this Eſſay. It there appears that if by this term is meant a power in one body to cauſe another to follow it; we ſhall hardly

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When a horſe moves a carriage, it is ſaid to *draw* or *attract* it. Yet, though the horſe goes before; ſome part of the harneſs, ſtrongly connected with the beaſt, muſt be placed behind to ſome part of the carriage, ſtrongly connected with the whole body to be moved. So that even in this (the moſt literal of all attractions) the effect is done by impulſe ſtrictly ſpeaking.

That a term, to which there is ſcarce any thing in nature ſtrictly anſwerable, ſhould be ſo generally uſed, to expreſs ſo many unaccountable things, is itſelf very unaccountable. All real attraction is the effect of ſome impreſſion made on the ſenſes, or on the mind by perſuaſion; ſo that the word belongs to metaphyſicks, and has, ſtrictly ſpeaking, no place in natural philoſophy.

P. 7. *Which ſome philoſophers draw.*]—The *materialiſts* ſeem to have founded their atheiſtical ſyſtem on this ſuppoſed gravitating power inherent in all matter. Hence

Leibnitz ſays ' Atoms (*monades*) ' have ' their proper perceptions.' And Hobbes aſſerted that ' all matter thinks.' Another opinion is, that ' every ray of light is an ' intelligent ſpirit (or vehicle of a ſpirit) ' employed in the various operations of ' nature.'

P. 1. *Two hundred thouſand times.*]—An eminent aſtronomer ſays *one* hundred thouſand. But by obſervation on the ſatellites of Jupiter it has been computed that the light of the Sun is about eight minutes coming to the Earth, that is about twelve millions of miles in a minute, or 200,000 in a ſecond. If the light of a lamp moves at the ſame rate it will fill its orb, of four miles in diameter, two hundred thouſand times every ſecond.

P. 11. *Every minute is changed.*]—A learned friend, whoſe ſituation gives him an opportunity of knowing all the improvements in experimental philoſophy, has informed me that ' the experiment here alluded to muſt be a miſtake.' And another friend, eminent in the line of aſtronomy, writes me that, ' the burning candle does not conſume a gallon of air in a ' minute. A ſmall quantity in fact loſes ' its aerial form; but the whole is rendered

'incapable of aſſiſting flame by being ſatu-
'rated with phlogiſton. This (he adds)
'is the philoſophy of the day.'

If ſo, it may not be the philoſophy of to-morrow, as it certainly was not ſome time ſince. But however this is, it makes no difference in the preſent caſe. All that is meant to be aſſerted, as ſufficient to the preſent purpoſe, is that by ignition a very large quantity is ſo changed, as to be unfit for maintaining flame or animal life, and that from the burning lamp iſſues an immenſe quantity of rays of light. Something is continually *deſtroyed* or changed in its nature, ſo as to loſe its diſtinguiſhing properties: and ſomething is continually *generated,* or becomes apparent, which did not exiſt in that manner before. And when ever philoſophers talk of *producing fire,* or *generating air*; they muſt be underſtood to mean making latent fire become viſible, and changing atmoſpherical (or ſome kind of) air into another kind, by compounding or decompoſing.

In the preſent caſe of the burning lamp, whatever name is given to the change, ſome change there certainly is. And it is natural to ſuppoſe that theſe changes are ſo balanced, as mutually to ſupply the defects occaſioned by them, and thus contiue a circulation of cauſes and effects.

It was an obſervation (or an opinion) of Plato, that 'fire expands all bodies, 'and air compreſſes them.' This principle may help to explain the phænomena of combuſtion: in all which no new matter is produced, nor any old matter loſt; but air (or part of it) may be changed into rays of light, and light again reſume its aerial nature.

It is aſſerted that in ignition, 'only a 'ſmall quantity of air loſes its aerial form.' Some air then, it ſeems, does loſe its aerial form or nature. And this may be that ſpecies of air (mixed with others in the atmoſphere) which is fit to maintain the flame. And this is probably that *pure* air, peculiarly ſuited to maintain life and fire; or that *inflammable* air which ſo readily catches into a flame, and which, by its ſuperior rarity and elaſticity (ſhewn in the air-balloon) may ruſh into the flame: eſpecially is nitrous air ſuited to maintain fire. Indeed nitre has this peculiar property, that fire will burn *in vacuo* conſuming nitre. Or theſe different ſpecies of air united may be the *pabulum* of the lamp, leaving other kinds of air,

with

with which the atmoſphere abounds. For that air is more eſſentially the *pabulum* of flame than oil, or fat of any kind, appears from the vaſt quantity of air that is conſumed, while a part of the oil ſtill remains unconſumed, in the ſmoke and ſoot; at leaſt not ſo far conſumed as to diſappear.

In this, as in many other circumſtances, there is a reſemblance between flame and animal life. Flame requires ſome groſſer ſupport, from the oil and wick, to prevent its diſperſion; but its more neceſſary food is air. So life can ſubſiſt for hours and days without food, but not many minutes without a freſh ſupply of air.

P. 12. *The great lamp of Heaven.*]—It is not neceſſary to ſuppoſe that the vaſt body of the Sun ſhould be an entire globe of light or fire. It ſhould ſeem ſufficient, for all the important effects aſcribed to it, if its atmoſphere only was fire. Surrounded by ſuch a flaming body to the thickneſs only of ſome thouſand, (or even hundred) miles, its interior part (like the *nucleus* of a comet) may be very different. It may be an habitable world; perhaps the region of pure ſpirit, ſpirits, who unencumbered with earthly bodies cannot be priſoners on the Earth; but fitted for nearer manifeſtations of the divine perfections.

P. 12. *Diffuſing every inſtant its light.*]—A friend obſerved on this paſſage that ‘the emiſſion of light, without a power of ‘repulſion, is as inconceivable as Sir ‘Iſaac Newton’s Gravitation, without a ‘power of attraction.’ To this it may be replied:

I. The gravitation objected to in this inquiry is not Sir Iſaac Newton’s. He diſclaims it as a *cauſe*: therefore his Great Name ſhould not be uſed to vindicate, or excuſe the meaning in which it is uſed by ſome that call the ſyſtem *Newtonian*.

II. If in this objection, by *repulſion* is meant that which is conſidered as acting at a diſtance, this is owned to be as inconceivable as *attraction* acting at a diſtance. But no ſuch repulſion is here meant, only a mere impulſe by contact. This is as conceivable as the power by which water drives a wheel.

P. 12. *Extent of the ſolar ſphere.*]—According to this view, the Sun and fixed ſtars (theſe being ſuns alſo) compoſe one great ſyſtem; and inſtead of being inſulated,

lated, or ſeparated from one another by vaſt regions of empty ſpace, they may be all connected by their reſpective emanations. And this connection may be attended by important conſequences. Therefore when we ſpeak of the rays as returning to the Sun again (under the form of æther) it is not ſuppoſed that this reflux is always the identical matter of the efflux; but only that it is equal to it, ſo as to reſtore the equilibrium. When the efflux of one Sun is involved in the reflux of another, the balance is reſtored by the elaſtic nature of the ætherial fluid.

P. 14. *The diſtance of the fixed ſtars.*] — Sirius, becauſe the brighteſt, is ſuppoſed to be the neareſt of all the fixed ſtars; and his diſtance is computed by Huygens to be 27,664 times farther from the Earth than the Sun.

With reſpect to the number of viſible ſtars we are told that Dr. Herſchell counted 44,000 in a few degrees. Suppoſing them to be equally thick in all the other parts of the Heavens, the number will amount to ſeventy-five millions. The combined emanations of theſe acting in various directions, on bodies near the Earth, except where they are intercepted by the Earth;

and with immenſe velocity may (eſpecially combined with the ſolar, lunar, and planetary emanations) be adequate to the effects expreſſed by *gravity* and *coheſion*. And this collection of Suns is the moſt glorious diſplay of divine Power in any of the viſible works of creation.

Seventy-five millions of *Suns*, all fountains of light, (and probably producing other important effects) pouring their emanations on one half of the Earth (and all other bodies) continually, with a plenty of rays beyond conception, and a frequency of impulſe immenſe! Each of theſe throws his emanations on every point of the Earth's ſurface, and probably thro' the centre of the globe. And all theſe emanations paſs through the ætherial expanſe, in ſuch a manner as to occupy every part in various directions, yet without interrupting one another: otherwiſe viſion could not be diſtinct. Yet by the united impulſe of ſo many ſwift bodies the Earth is not compacted to a flint; but the emanations are of ſuch a kind as to leave (perhaps cauſe) a proper degree of firmneſs and ſoftneſs in the texture: ſuited to produce fruitfulneſs in the ſurface, and the interior parts (and indeed in the interior of every ſubſtance upon it) ſuch a ſtate as is ſuited to the various operations directed by the *Great Creator*.

All this ſeems too vaſt, too aſtoniſhing for the imagination, with its utmoſt ſtretch to conceive: yet the whole is deduced from ſuch fair plain deductions, that reaſon finds itſelf compelled to acknowledge —'All this may (it *muſt*) be ſo.'

P. 13. *The ætherial reflux.*]—To avoid miſtakes it may be uſeful to define the terms here uſed.

By the *æther* is meant that ſubtil medium in which the planets are ſuppoſed to move: by the *efflux* the ſolar rays acting as a centrifugal force: by the *reflux*, or *ætherial reflux* is meant that part of the æther which preſſes towards the ſun. What is ſometimes called *efflux* at other times may be called *emanation*. And what is called *reflux* to expreſs the compenſation made to ſupply the *emanation*) may otherwiſe be called *influx*, or *refluent æther*. Sometimes one of theſe words may ſeem to be put for that which has an oppoſite ſenſe. But this may be done without any impropriety: for what is an *efflux* or *emanation* with reſpect to the body from which it proceeds, may be an influx or reflux with reſpect to the body towards which it tends.

The reader is deſired to have recourſe to this note, if he finds any obſcurity in the uſe of theſe words.

P. 13. *Meeting yet not interfering.*]—It has been proved that the velocity of light is diminiſhed in its courſe: and this diminution has been aſcribed to the attractions of the body from whence it proceeds. May not this gradual diminution in the velocity of the rays of light be cauſed by the reſiſtance of the æthereal fluid in an oppoſite direction? By this diminution of the velocity the force may be intirely ſpent, by the time the rays reach the moſt diſtant object intended to be enlightened and impelled by them. This interference then may be ſuch as to contribute to the great end to be effected, and not ſuch as to hinder it.

P. 15. *Variety of experiments.*]—That light or fire is really a body has been thought to be proved by the following experiment. Quickſilver kept long in a gentle heat becomes ſolid, and increaſes in weight. Which effect is aſcribed to the addition of fire.

Homberg, Acad. of Sciences, 1708, p. 25, relates the following experiment: 'A light 'matter, ſuch as the amianthus, being ſud-

'denly brought into the focus of a burning 'glaſs, was driven off by the concurring 'rays of light.' So the looſe end 'of a 'watch ſpring vibrated:' *Nieuwentyt's Religious Philoſopher.* A ſimilar proof of the power of the ſolar rays is drawn from their moving a pendulous body, by ſuddenly ſtriking on it.

To theſe experiments it has been objected that 'in all theſe caſes the motion aroſe from the air being rarefied.' But how was the air rarefied? Was it not by the ſolar rays? And could they rarefy and move the air without ſtriking on it by a ſenſible *impetus*? It requires the ſame power to move the air firſt, and by this motion (whatever name it is called by) to move the watch-ſpring, as to move the ſpring immediately.

We are apt to ſpeak of the ſolar rays merely as objects or means of viſion; and as if they had no exiſtence when not ſeen. But, if we attend to what paſſes daily before our eyes, we ſhall ſee that they produce effects not at all connected with viſion.

Their impulſe on ice, wax, and various other things, ſeparates the parts; ſo as to make that fluid which before was ſolid.

On clay they produce an effect quite oppoſite. Water is raiſed by them to a thin vapour. They diffuſe life and beauty into all the parts of the creation. The Sun itſelf would be uſeleſs without theſe active emiſſaries; as impotent as a general without an army.

If the ſolar rays are effectual to the producing ſuch a variety of great operations; can it be thought incredible that they ſhould be employed in directing the motions of thoſe orbs, whoſe well-being and uſefulneſs ſo viſibly depend on their activity?

P. 13. *This reſiſtance imaginary.*]—Yet *Nieuwentyt* mentions it as a proof of the almighty power of God, that 'He could 'move Jupiter.' And Dr. *Clark* (though he ſuppoſed his *ſubtil fluid* capable of penetrating the planetary orbs) aſks 'How can 'ſuch a cauſe impel vaſt bodies?' And a learned friend has obſerved, 'It is difficult 'to ſuppoſe any matter capable of pene'trating to the centre of a planet, yet groſs 'enough to induce the neceſſary effect by 'impinging.'

These great men ſeem to think that every ſquare foot in a planet requires as much to move it, as an equally large quantity of matter taken from the ſurface of the Earth. But in this laſt caſe there is real weight or gravity, owing to a cauſe hereafter to be conſidered. In the heavenly bodies we have no proof of any weight; or tendency to move one way rather than another, independent of external impulſe. The *vis inertiæ* is an imaginary effect connected with attraction, a cauſe equally imaginary. They are both neceſſary, and both inconceivable; unleſs we admit ſuch a miraculous kind of agency as we find in no part of the ordinary courſe of the works of GOD.

But when this imaginary obſtacle (the *vis inertiæ*) is removed, there remains no reſiſtance to the moving powers, but the medium in which the planet is placed; and comparing this reſiſtance with the moving power, it ſhould be remembered that the *momentum* of all bodies ariſes from the bulk multiplied by the velocity. Of the ſolar rays the ſize is indeed extremely little, but their number is proportionably great; and their velocity immenſe. With reſpect to the centripetal force or refluent æther, *Sir Iſaac Newton* was perſuaded it was equal to all that was called gravitation, provided the æther moved conſtantly towards the Sun. Indeed it muſt be nearly equal to the ſolar rays in its *momentum*, becauſe it ſupplies the vacuity cauſed by the emiſſion of them. And to ſay that the æther is too denſe for theſe to overcome (the body being originally ſet in motion) is an aſſertion too bold, till we are better acquainted with the contents of this ſubtil fluid.

P. 16. *As far exceed our atmoſphere as this does the ocean.*]—A very ſimple experiment ſhews that water is air condenſed, and air is water rarefied, and this rarefaction is cauſed by an increaſed degree of heat. For water heated becomes ſteam and mixes with the atmoſphere or air. This air condenſed by cold becomes water again. This is the principle on which the ſteam engine acts. If water and air are thus mutually convertible by adding or withdrawing fire, it is not incredible that the ſolar rays (or fire) may be convertible into pure air or æther, and this again convertible into fire, by the operation ſimilar to that which raiſes water to air, or condenſes air to water.

Abbe Lavoiſier proves by experiment, that the atmoſphere conſiſts of 27 parts of a pure air, and 73 parts of mephitick air.

Another experiment made in the Royal Academy of Sciences in Paris, tends to ſhew that 85 grains of vital air and 15 grains of atmoſpherical air together made 100 grains of water. Theſe experiments ſhew that water and air are the ſame thing differently modified. Probably all bodies are eſſentially the ſame, differing in the ſize and ſhape of their parts.

P. 24. *Proportioned to the quantity of matter.*]—This Mr. Ferguſon ſays ſhould be the caſe but does not ſee how it can be effected: not comparing the extreme minuteneſs of the rays with the poroſity of the Earth, nor forming an adequate opinion of the momentum of their impulſe reſulting from their extreme velocity. 'Gravity,' ſays he, 'ſhould ſeem to riſe from 'the agency of ſome ſubtil matter, preſſing towards the Sun and planets;' [probably he means towards the Sun and taking the planets in its courſe;] 'and acting like all 'other mechanical cauſes by contact. But 'on the other hand when we conſider, that 'the degree, or force, of gravity is exactly 'in proportion to the quantities of matter 'in thoſe bodies, without any regard to the 'quantities of their ſurface, acting as freely 'on their internal as external parts, it ſeems 'to ſurpaſs the powers of mechaniſm.' Not at all, if the power has acceſs to the object.

P. 24. *The centrifugal force does not operate.*]—A friend, of whoſe judgment I have an high opinion, thinks that the inferiority of power in the ſolar efflux, compared with that of the ætherial reflux, may be compenſated by the different ſides, on which the two powers ſtrike the planet. This difference is the diameter of the planet and on the Earth amounts to 8000 miles; and is proportioned not to the diſtance of the two ſides of the planet from the Sun, but to the ſquares of the diſtances inverſely.

If to this it be objected; that 'the two 'powers do not fall on the ſurface only, 'but on every particle of matter.' To this it may be replied; that though they impinge on every part, it is not with equal *impetus*. Both the ſolar efflux and the ætherial reflux muſt have their force leſſened by ſtriking ſucceſſively on the different parts, and be exceedingly diminiſhed when they reach the centre of the planet; and ſtill more ſo when they arrive at the ſide oppoſite to that on which they enter. This circumſtance will ſtill leave a ſuperiority of power in the ſolar efflux to that of the ætherial reflux, probably ſufficient to counterbalance the diminution of power, cauſed by the obliquity of the ſolar rays.

P. 22. *Truth of any ſyſtem.*]—If this matter be examined attentively, our own obſervation will ſhew that the Sun's rays do really penetrate the Earth, in the manner here deſcribed.

When they reach the atmoſphere ſome of them may be reflected by the clouds; but many more reach the Earth; as appears from the light and heat even in the darkeſt day.

If in a clear day the ſolar rays fall on water, many appear reflected. But ſtill many penetrate as appears from the objects ſeen at a great depth.

If the water be ruffled or diſcoloured, we ſee no objects at the bottom; but though we have not now this proof that the rays have penetrated, we cannot imagine that the motion of the water, or ſlight tinge of colour can make any real obſtruction to them.

If inſtead of water the rays fall on a tent, or the roof of a houſe, many are reflected; but many penetrate; as appears from the warmth felt in the tent or room. If the covering of the tent be white, a great part of the rays are reflected, and fewer enter.

If this ſame covering be painted black, a greater number penetrate; but the light within is leſs. If the houſe be covered with wood or ſtone, the rays are interrupted ſo far as to hinder viſion entirely: but their preſence is diſcovered by the heat. And it is inconceivable that ſuch ſmall bodies, moving with ſuch immenſe ſwiftneſs, can be excluded by ſuch a porous ſubſtance. In fact they penetrate to the bowels of the Earth, and preſerve it from being frozen. For it appears from experiments that the degree of heat is nearly the ſame at different depths. *See Mr. De Luc's account of the mines in Haartz Foreſt.*

From the preſence, number, and activity of the ſolar rays, may be explained all the appearances and effects of ſubterraneous fires and vapors, as they are more or leſs collected, and mingled with matters combuſtible or fermenting. Their power in the burning-glaſs ſhews, that they are equal to the productions of hot ſprings, volcanos, and earthquakes. They are probably (under the direction of the Almighty) the cauſe of the vapors that riſe in marſhes; of waterſpouts, and pillars of ſand (ſuch as Mr. Bruce deſcribes) in ſandy deſerts; and of that noxious air that accompanies them. All theſe ſeem to be

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the effects of ſtreams of fire, combined with other things, ruſhing impetuouſly from the bowels of the Earth. But all fire is probably derived from the ſun, except that which reaches us from thoſe other ſuns, the ſtars. Theſe ſame rays may alſo be the chief inſtruments in forming the various minerals, gems, and loads which miners find; compoſing a kind of ſubterraneous vegetation.

P. 24. *That part of the æther.*]—It ſeems highly probable that the æther (like the atmoſphere) is a mixture of very different fluids; and that only part of it preſſes (as a centripetal power) towards the Sun; that part which correſponds to the *pure* or the *combuſtible* air, or both, in the atmoſphere. This part will ruſh of courſe to the Sun as its proper *pabulum*, by its ſuperior elaſticity. Probably æther is a more ſubtil air, and air a groſſer æther; as water is condenſed air, and air rarefied water. Mr. Hutchinſon ſays 'Light is not the 'iſſue of the Sun, but the Sun is the iſſue 'of light.' Vol. 1. p. 54.

The former part of this ſentence is contrary to daily experience; but the latter part may be true. The Sun may receive from the æther a fluid, which becomes part of itſelf; and which it ſends off in that ſtate which we call light. And this either in itſelf, or mingled with ſome kind of air, produces fire. Indeed all bodies ſeem to receive from the air or æther a pabulum ſuited to them, and ſend it off again variouſly modified according to their different natures.

P. 25. *Their different magnitudes.*]— This agrees with that rule, *Quicquid recipitur, recipitur in modum recipientis.* Where the cauſe is the ſame, the effect will be according to the different capacity and ſuitableneſs of different objects.

P. 31. *Light is a body.*]—This appears to be the truth from the experiments already mentioned, but if it is not a body, what is it? A motion? Or vibration? This ſuppoſes the preſence of ſome body to be moved, or to vibrate.

It is either ſomething or nothing: if nothing, we ſee nothing: which is abſurd. If ſomething, it is matter or ſpirit. But who can ſee ſpirit? If matter, it muſt have a durable exiſtence; not depending on being ſeen or felt; but exiſting when we neither ſee nor feel it. As it was the firſt of all the viſible creatures of God; it will probably laſt as long as any part of the creation; indiſtructable by any power, but that of Him that made it. Yet many perſons ſpeak of light as exiſting no longer than they ſee it; as a quality without any ſubſtance of which it is a quality, in ſhort as a luminous—nothing.

If we fancy that light exiſts no longer, when we do not ſee it, we may as well fancy that the Sun is annihilated, when he is hid behind a cloud; or when we ſhut our eyes.

Where, at midnight is that blaze of light which ſhone at noon? We ſee it not, becauſe by the interpoſition of the Earth, it is prevented from falling on our eyes. Yet we know, it fills as large a ſpace as in the day; even the whole expanſe of the viſible Heavens; except that very ſmall part on which the Earth's ſhadow falls.

P. 33. *The right cauſe.*]—A friend, who ſaw this eſſay in manuſcript, thought the ſyſtem here maintained was nearly the ſame as that of Mr. *Hutchinſon.*

This made me conſult that writer; and in his *Moſis Principia* I found the following words: 'The light is preſſed out by 'the influx of the ſpirit, and the ſpirit is 'preſſed in by the influx of light. And 'the whole matter of the Heavens or air is 'perpetually changing condition, or circu'lating.'

This account of light ſeems very dark. But if by *light preſſed out* is meant the efflux of ſolar rays; and if by the *influx of the ſpirit*, he means the preſſure towards the Sun of the ætherial fluid, or ſuch parts of it as are ſuited to maintain the ſolar fire; and if by the *ſpirit preſſed in by the influx of light*, is meant any part of the ætherial fluid flowing towards the Sun, in conſequence of the vacuity made by the emiſſion of the ſolar rays and their return towards the Sun; and if by the *whole matter of the Heavens or air*, he means the ſolar rays emitted, and the ætherial fluid preſſing towards the Sun, conſidered as one and the ſame body under different circumſtances. Thus underſtood the ſyſtem here maintained, and that of Mr. *Hutchinſon* may be the ſame or ſimilar. But, it muſt be owned, it is more eaſy to diſcern this ſyſtem, by contemplating the Heavens themſelves, than by ſearching into the meaning of ſuch terms as Mr. *Hutchinſon* uſes.

P. 35. *Different principle.*]—A learned friend, who in conſequence of my requeſt to be a ſevere critick, has favored me with remarks, which have been of great uſe, on the ſubject of the comets, ſays—'That 'ſince comets and planets follow the ſame 'laws in their motion, it ſhould ſeem that 'they are not moved by different powers:' or that both are moved by attraction.

It is not here ſuppoſed, that they are moved by different *powers*. The Sun by his emanation moves them both; but they are certainly not moved by the ſame *laws*; as is ſuppoſed, to ſupport the univerſal power of attraction.

The planets, for inſtance, move from Weſt to Eaſt, the comets move in all directions.

The planets, compared together, move in proportion to their quantities of matter, and inverſely as the ſquares of their diſtances: but who ever diſcovered the quantities of matter, or the diſtances of the comets to aſcertain theſe proportions?

We are told indeed that both planets and comets in their orbits deſcribe equal areas in equal times. But with reſpect to the comets this law muſt be imaginary; as the periods of them are not yet aſcertained.

From hence might be drawn an argument againſt attraction, as the power by which the planets and comets are ſuppoſed to be moved. If both were moved by the ſame attractive force, both would move by the ſame laws.

P. 36. *The Sun and comets.*]—*Tycho Brahe* thought the tails of comets were produced by the Sun's rays, tranſmitted thro' the nucleus.

Euler thought them to be the atmoſphere of the comets, driven off by the Sun's rays.

Theſe two opinions are here cited to ſhew that the penetrating and impelling power of the ſolar rays is no novel imagination; but entertained long ago by ſome of the greateſt aſtronomers, though for purpoſes different from that for which it is uſed in the preſent *inquiry.*

P. 37. *Similar to electrical phænomena.*] —In inveſtigating the analogy between electricity and the cometary ſyſtem, it may be of uſe to conſider the following circumſtances, obſerved by electricians.

I. Some of thoſe bodies which are eſteemed non-conductors, when heated to a certain degree, become conductors. May not this be applied to the change in the comet's motion, when it approaches the Sun?

II. *Hawkſbee*, and others ſince, have obſerved that there is a certain nick of time when bodies approaching the electrifier are repelled. And this repulſion is ſometimes directly from the globe, ſometimes in an inclined direction: it depends alſo partly on the nearneſs of approach. Theſe remarks may be applied in the ſame manner as the laſt.

III. Electric bodies (ſuch as the Sun is ſuppoſed to be) attract and repel alternately.

IV. Some bodies are electrified poſitively, ſome negatively: and theſe different qualities are changed to their oppoſites in certain circumſtances.

V. *Abbe Hemmer* has lately diſcovered that the flame of every burning body is electrified negatively.

The application of theſe diſcoveries will afford exerciſe to the ſtudent in cometo-electricity; a large field not yet cultivated.

P. 38. *Hinder it from returning.*]— Comets for any thing that we know as yet, may be connected with other ſyſtems, and paſs, by an electric impulſe, from one Sun to another. They may be as rapid in their aphelion, as we call it, by approaching another ſun, as they are in their perihelion, or approach to our Sun. For though we have their path marked in *cometariums* formed on the imaginary *law of attraction*, this ſyſtem is only on paper. Till their periods are better known, there can be no proof of this plauſible ſcheme.

Comets may be the chains that connect different ſyſtems of ſuns, and their revolving orbs. For that there is ſome connection is very probable, as they are all the works of the ſame CREATOR. Indeed we ſee that there is ſome connection, by the ſolar and ſtellar emanations paſſing from one to another, throughout all the viſible expanſe of the Heavens; and probably far beyond it.

P. 38. *A myſtery not yet explained.*]— Such myſteries abound in all the three books given for the inſtruction of mankind; the books of *Creation*, *Providence*, and *Revelation*. In all theſe we may diſcover much, but many things will ſtill remain not thoroughly underſtood. From this ſimilarity, a fair concluſion may be drawn, that they are all the works of the ſame Au-

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thor. We may not therefore reject any of them, becauſe they have ſome things that we cannot fathom. The parts that do not add to our ſtock of knowledge in any other way, may inſtruct us in one important point, that there are ſome things which we are yet to learn.

He that in philoſophical inquiries will not believe any thing, which he cannot explain; nor thinks any thing knowable which he does not yet know; will make very little progreſs. Such a ſceptiſm in religious matters leaſt of all ſuits them, who have been accuſtomed to talk of *gravitation* and *attraction*, as *powers* and operating *cauſes*.

P. 40. *That the Moon has a great emanation.*] The light of the Moon may be ſeen through a hole the fiftieth part of an inch. In every ſquare inch then, on the half of the Earth's ſurface turned towards the Moon, there fall at the ſame time 2,500 times as many of the lunar rays as are ſufficient for viſion. And if there had been as many Earths ſurrounding the Moon (at the utmoſt diſtance where it is viſible) as would be ſufficient to form a circle of Earths touching each other; nay, as many as would be ſufficient to complete a ſphere encloſing the Moon every way: her efflux would be ſufficient to enlighten them all: except when they might eclipſe one another.

P. 41. *More powerful effect.*]—This more powerful effect of the lunar emanation appears from the conſequences of being expoſed to the ſtroke of it, as ſpecified in the next paragraph; and is plainly alluded to in that paſſage, Pſ. 121, v. 6. *The Sun ſhall not ſmite thee by day, nor the Moon by night.*

The fatal effects of being *ſmitten* by the Sun are well known in hot countries. It is here ſuppoſed that the Moon alſo has ſimilar baneful powers; otherwiſe it could not be mentioned as a mercy ſhewn to the godly, that the Lord is ſo far their *ſhade*, as to keep them from its hurtful influence.

P. 47. *The line that marks her path.*] The line of the Moon's annual orbit is not eaſily underſtood without repreſenting it in a plate. But this is done in moſt books of aſtronomy, and the figures there drawn will ſerve to explain the preſent deſcription with a few alterations of expreſſion.

At the time of New Moon ſhe is between the Earth and the Sun. Then, and the ſeven following days, the eaſtern inclination of the Earth's impulſe is contrary to the eaſtern inclination of the Sun's impulſe. For when two bodies move round themſelves in the ſame direction, their *radii* will move in contrary directions one half of the orbit; as may be ſeen in the fore wheels, and hinder wheels of a carriage. By means of this contrary impulſe the moon is ſo much retarded in her annual journey, as to be at the end of ſeven days 240,000 miles behind the Earth, which diſtance is equal to the ſemi-diameter of her orbit.

On the eighth day (her firſt quarter) the Earth's impulſe ceaſes to be contrary to that of the Sun, Theſe two therefore acting together ſhe now moves rapidly, and in ſeven days more overtakes the Earth, and being in oppoſition (the Earth between her and the Sun) it is Full Moon.

In the next ſeven days, the impulſe of the Earth and the Sun continuing to act in the ſame direction, the Moon advances 240,000 miles before the Earth: this is her laſt quarter.

From this time the two impulſes are oppoſite, and retard the Moon as in its firſt quarter. So that at the end of ſeven days more the Moon is brought back to the ſame poſition, between the Sun and Earth, as in the beginning. She is now again a New Moon; at leaſt will be ſo in two days more: which is neceſſary on account of the Earth's having advanced in its orbit, while the Moon was going round it. For though the Moon goes round the Earth every month; both Earth and Moon impelled by the Sun go round him in a year; and keep very nearly at the ſame diſtance from each other.

All this is commonly explained by the commodious term *attraction*; in which are ſuppoſed two very extraordinary circumſtances. It is allowed that the Sun's light or emanation reaches both Earth and Moon, but this emanation is not ſuppoſed to have any effect on either of them. It is alſo ſuppoſed that Sun and Moon and Earth all attract one another, without any actual contact of any impulſive emanation from one to the other. There is a viſible impulſe which contributes nothing towards moving them; and there is a mutual moving without any viſible cauſe.

P. 47. *Guided in her orbit.*]—There is one peculiarity in the Moon's motion, which the preſent theory accounts for eaſily. According to a general law, confirmed by experience, different planets are moved (except ſo far as depends on their diſtance from the Sun) with different velocities proportioned to the quantity of matter contained in them. But the Moon (though much leſs in bulk) moves, in the whole of her orbit taken together, with the ſame velocity as the Earth; at nearly the ſame diſtance from the Sun.

To explain this we muſt take into the account (not only the centrifugal and centripetal powers of the Sun, the Eaſtern inclination in conſequence of his motion round its axis, but alſo) a third cauſe: while the Earth impels the Moon, it is moved itſelf eaſtward with great velocity. The radii therefore, iſſuing from the Earth, when they reach the Moon muſt have a conſiderable *impetus* eaſtward, in addition to that which they have otherwiſe. Every body proceeding from another muſt partake of all the directions of that from which it comes.

If it be ſaid that ‘ the reſiſtance which ‘ the Moon meets with is leſs than that 'which obſtructs the Earth, and that this 'difference in the reſiſtance is a balance 'to the difference of impulſe;' it may be anſwered that the proportion between theſe does not agree, ſo as for the one to counterbalance the other. The impulſe of the ſolar rays, on the Earth, and Moon is proportioned to the quantity of matter in each. The reſiſtance of the medium is in proportion to the ſurface. Of courſe the Moon being the leſs body, her reſiſtance bears a greater proportion to her impulſe, than the reſiſtance made to the Earth does to her impulſe. For this reaſon the Moon would be retarded in her courſe, and be left behind the Earth. But this being not the caſe, ſome other power muſt be employed to prevent the effect; and no other power appears but that which is here aſſigned: nor is any other wanted.

P. 48. *Whence a great part of the power proceeds.*]—The ætherial fluid is generally conſidered as little better than a mere vacuum, and of little conſequence in creation. But, though we know but little of it, we know enough to convince us that this is a great miſtake. In extent it is ſuperior to all things. With reſpect to occupying ſpace, there is not the leaſt part in all the viſible expanſe, that is not (in a ſenſe) filled with it. But what is it that is thus expanded? In every minute part are corpuſcules of very different kinds. Luminous bodies iſſuing from the Sun, Moon, planets, and ſtars muſt be in every part, where theſe bodies can be ſeen by the beſt eye. For no body can be ſeen without a certain quantity of luminous rays. But beſides cauſing a ſight of the different bodies from which they proceed, it is highly probable they ſerve other important purpoſes, even beſides that of guiding the different bodies that float in them; purpoſes worthy of Him that made this immenſe ocean.

P. 50. *The atmoſphere grows leſs denſe.*] —The atmoſphere ſhould not be confounded with the æther, the ſubject of a former note. This laſt penetrates and impels every thing. The atmoſphere is penetrated and impelled, and is eaſily excluded from many places. Thus by being excluded from the top of the barometer, its weight or preſſure ſuſtains a column of quickſilver equal in weight to itſelf. But the æther penetrates and impels the tube and its contents. And the reſiſtance made to this impelling power conſtitutes the weight of all bodies; which impelling power is probably the united emanation of the Sun, Moon, planets, and ſtars.

As every particle of matter is impelled by the ætherial efflux and reflux, the weight of the atmoſphere will always be in proportion to the quantity of matter contained in it. This weight, and conſequently the quantity of matter, is aſcertained by the barometer.

This is the reaſon of the quickſilver's falling as we aſcend hills; there is a leſs column of air ſuſtained.

P. 55. *This ſame principle prevails.*]—That is the principle by which bodies are impelled, according to the quantity of matter contained in them, by the centripetal reflux. There is alſo a correſponding principle, by which bodies impel others according to the quantity of matter contained in the bodies from whence the emanation proceeds. Theſe two diſtinct principles are ſpoken of together in this place, but they ſhould not be confounded.

P. 52. *This reflux of æther approaches the Earth.*]—What has been ſaid of the neceſſity of this return or compenſation, with reſpect to the Sun and Moon, is equally applicable to the Earth. Without a ſupply of air a lamp is extinguiſhed; and the Sun itſelf without the *pabulum* of the ætherial fluid (by parity of reaſon) would be dark. The Earth, for ſimilar reaſons (without a like ſupply) muſt loſe its fire, and with that, its active powers internal and external. In a word, ſuch a continual large expence muſt exhauſt it, without a proportional return. On the other hand, if the Earth was to receive a continual influx from the Sun and other bodies, the vaſt quantity of fire amaſſed would not only occaſion fires and volcanoes, but deſtroy it; unleſs relieved by an efflux from herſelf. This continual change ſeems neceſſary to the exiſtence, as well as to the external operations, of all the parts of creation.

(In ſpeaking of the ſpring tides, it was ſaid that they were cauſed by the ætherial efflux and reflux (from and towards the Sun and the Moon) being in the ſame direction. If what is here aſſerted be true, that theſe ſame fluids paſs through the land as well as the water, their effect will be greater on the land, as well as on the ſea, about the time of New and Full Moon. This increaſe of effect on the land is not eaſily perceived; but a French philoſopher records a phænomenon in the lands near Hudſon's Bay, which he thinks cannot be accounted for, but may be explained from this united impulſe. After ſaying that 'in the winter it is no uncommon thing to ſee rocks ſplit by the froſt,' he adds, that 'theſe effects were more terrible at the time of New and Full Moon.' *Raynal's Philoſophick Hiſtory*.

P. 56. *The ſagacious dog*.]—A dog has been known to diſtinguiſh his maſter in the dark, after being long ſeparated from him. Here is a proof that the effluvia of animals differ from thoſe of other things. That from man is ſenſibly different from what proceeds from other animals. Every man has an effluvium, the particles of which are different from thoſe of other men. A dog has a faculty of diſcerning this difference: and a memory, (or ſomething like memory) capable of preſerving a knowledge of the different impreſſions made on his olfactory nerves. So that animal effluvia have a penetrating and impelling (or impreſſive) power, ſimilar to that (though probably in a much inferior degree) which has been aſcribed to the ſolar rays and refluent æther. This odorific efflux may be the ætherial fluid mixed with animal particles floating and mingling with the atmoſphere.

This effluvium of animals is conſtant, but differing in degree and other circumſtances. At certain ſeaſons it has a quality very ſtrongly perceived by animals of the ſame ſpecies, and which thus becomes ſubſervient to very important ends.

P. 56. *Sometimes abſorbed by other bodies.*]—On this depends ſcent; and this is the ſource of the joys of the hunter. The common notion ſeems to be that the effluvium of the animal floats in the air; but it is impoſſible that this ſhould be the caſe long. The wind would ſoon diſperſe what did not adhere to ſome fixt body. The graſs and buſhes (perhaps the Earth itſelf) receive the odorous efflux, retain it, and diſcharge it gradually. This animal efflux is thought by ſome to be nutritious to the plant. It may be ſo; but we ſee other inſtances of perfumes received, and retained in ſome meaſure, and gradually diſcharged for a long time. This is another inſtance of the extreme minuteneſs of the particles of matter, and their activity: ſo that the ſolar rays and æther are not the only inſtances of this pervading power.

P. 56. *Diſeaſes quickly follow.*]—In perfect health this efflux is ſo rarefied as not to be perceived. When increaſed by motion or otherwiſe it is very apparent in *ſenſible* perſpiration. When this diſcharge is obſtructed it may be promoted by exerciſe, warmth or medicine: otherwiſe it becomes a dangerous enemy, hence proceed bilious and nephritick complaints, gout and rheumatiſm, and various other diſorders according to the different parts of the body in which it ſtagnates. If protruded to the ſkin in a diſeaſed ſtate, it produces eruptions of various ſorts. Much goes off by the lungs; and, when interrupted, a temporary relief is obtained by convulſive efforts. But if theſe do not ſucceed, nor any of the artificial drains invented by art, the habit is oppreſſed.

Thus diſeaſes are often cauſed by an *obſtruction of perſpiration*; but in many caſes this will hardly account for the violent ſymptoms, colds, and fevers; and the reigning epidemicks, and endemial diſeaſes, which often follow the expoſure of a ſmall part of the body to the cold, and noxious air. In theſe caſes does it not ſeem more probable that an enemy is admitted, through the pores of the ſkin, into the conſtitution, than that ſo violent an indiſpoſition ariſes from retaining ſo ſmall a part of the perſpirable matter, as would have iſſued from ſo ſmall a part of the ſkin? The atmoſphere is a congeries of ſubſtances of infinitely various qualities, from whence different conſtitutions imbibe different parts, to their benefit or hurt, according as they are differently diſpoſed. The cold, for inſtance that ſtrengthens the habit of one man, ſends another to his bed with feveriſh ſymptoms. In this caſe the common expreſſion of *catching cold* may be more expreſſive of the cauſe of the diſorder, than the technical term *obſtructed perſpiration*. This laſt indeed attends the other (as crowding a paſſage by going in hinders others from coming out) and this is the complaint moſt felt, though not always the original cauſe.

P. 56. *In the vegetable world.*]—There is a ſpecies of emanation in vegetables that looks more like attraction (if it was poſſible for bodies to act at a diſtance) than any thing that has been called by that name.

The pollen or farina is neceſſary to the production of the fruit and ſeed. And by means of its great plenty, it ſeems to be generally ſuppoſed, that a ſufficient quantity of it reaches the ovarium, without any other guide than chance. Its plenty indeed is great; greater than is generally known:

known; for though the pollen be very ſmall, yet the microſcope ſhews that it is itſelf a ſhell containing many ſmaller ſeeds or pollens. But yet, if it had no directive principle in its paſſage; no other guide than chance, (in a ſtormy ſeaſon eſpecially) an acre of ground could hardly produce a pint of wheat. Such an important article is not truſted to chance, a word often uſed to exclude all regard to the divine Providence, but equally contrary to philoſophy and theology.

In many caſes the pollen muſt move a conſiderable ſpace, (even from one tree to another) and then enter a very ſmall long paſſage to reach its proper place. How is the floating little ball directed in its courſe? What proviſion has the Father Almighty made for its ſafety? May there not be in this matter ſomething ſimilar to the electric current, by which it is guided to the *ovarium*.

That this is really the caſe ſeems highly probable from ſome obſervations very lately made. At the critical ſeaſon ſome have obſerved a mutual inclination, towards each other, between the antheræ (from whence the pollen comes) and the ſtigma to which it flies. This bending of the organs towards each other is like the inclined poſition of the filaments of an electric feather; and may be owing to the ſame cauſe, the electric fluid paſſing to and fro, and conveying in the current the pollen to the place provided for its reception. This ſuppoſition appears to be ſtill more probable from an obſervation made by M. Haggaren, of Copenhagen; who ſaw a luminous appearance on ſeveral flowers in the months of July and Auguſt, 1787. See Crit. Review, Jan. 1789.

It is alſo recorded in the Swediſh Acts, that Miſs Linnæus obſerved that the garden naſturtium emitted flaſhes of light morning and evening. The ſame has ſince been obſerved by others with reſpect to other flowers.

Theſe wonderful phænomena of electric currents, moving in contrary directions at the ſame time, was not made to amuſe children (either young or old) but to direct the attentive mind to ſome important operations of nature; and teach us to adore the wiſdom and goodneſs of the Author. And what more important operation than that on which the preſervation of the whole vegetable world depends? For if the pollen did not reach its *ovarium* or *nidus*, there could be no ſeed capable of growing; and without ſuch ſeed no continuation of plants.

What makes the danger of the pollen or farina greater, and ſhews the neceſſity of ſome proviſion for its ſafety, is this: it is a favorite food of ſome inſects. We ſee the bees, eſpecially, and the large drones, carrying off great quantities, to make their combs; which are filled with honey drawn from the nectaries of flowers.

Indeed this very circumſtance is ſometimes overruled by the univerſal Parent, to be a means of promoting the diſperſion of the pollen to a diſtance. The bees drop ſome of their ſtores among other plants, as rooks diſſeminate the acorns by hiding them in the ground.

But this occaſional diſperſion would be very defective. Some eſtabliſhed law is neceſſary to continue the different ſpecies; and if we ſuppoſe the electric current is excited at the proper criſis to enlarge one part of the plant, and diſcharge the pollen from another part, and conduct it to its place (like the light bodies floating to and from the electrified tube)—This proviſion ſeems equal to the end.

This notion of an electrical power, being employed in the diſpoſal of the pollen, is farther confirmed by a paper very lately read before the Royal ſociety. It is alſo another inſtance of animals being occaſionally employed by the univerſal LORD in promoting the vegetation of plants:

'Dr. Smith communicated the reſult of 'an experiment, which he made on the 'common barberry. When the plant is 'in flower the ſtamina are bent backwards 'to each petal, ſheltering themſelves under their concave tips: one of the filaments being touched on the inſide will 'inſtantly ſpring from the petal with a conſiderable force, ſtriking its anthera againſt the ſtigma. By this the impregnation of the germen is unqueſtionably performed. When the ſtamina ſtand in 'their original poſition, the antheræ are 'effectually ſheltered from rain, by 'the concavity of the petals. Thus 'probably they remain, till ſome inſect 'coming to extract honey from the baſe 'of the flower, thruſts itſelf between the 'filaments; by which means the impregnation is effected.'

P. 57. *They languiſh and die.*]—All plants require not only earth and water, but air and light. And theſe laſt are more neceſſary than the former. Some, particularly of the ſedum kind, live with little or no earth; others thrive for a conſiderable time without water: but none do well without air or light. The air muſt be of a warmth ſuited to their natures; but air without light is not ſufficient. Nay, the light (to make them vigorous) ſhould fall perpendicularly upon them. Trees overſhadowed by others wither and die; and plants kept in a room ſtretch out their feeble branches towards the window, as if ſupplicating the neceſſary ſupply of light.

This ſhews that light and air conſtitute their food; which makes them live and flouriſh; and in exchange throw off a fragrance ſuited to their natures.

P. 57. *Support of animal life.*]—We were at a loſs to know, by what means the vaſt quantity of air rendered unfit for reſpiration, by fires and the lungs of animals, was renewed; ſo as to produce a ſufficient quantity of pure air. This ſecret is diſcovered. It ſeems, all plants (and even running water) abſorb the fœtid vapors, and return a pure dephlogiſticated air.

P. 58. *They diffuſe an emanation.*]—It is ſaid of antimony and mercury, that being kept in water, they will communicate a medicinal quality for years together, without loſing any part of their weight. This may be a vague aſſertion, implying that their parts are ſo minute, that they will have an effect without loſing ſo much as can be, or has been perceived. But if this ſhould be carefully examined, and found to be really the caſe; we ſhall have two proofs, from the mineral kingdom of the general ſyſtem: *emanations* thrown off, and the bodies recruited by the adjacent fluid. In this way it may be that perfumes retain their power ſo long. All theſe bodies may find ſomething in the air ſuited to their natures; and which they may have, by a kind of digeſtion, a power of aſſimilating.

P. 61. *All bodies would be compacted.*]—It is found by the barometer that every ſquare inch near the Earth ſuſtains fifteen pounds of the atmoſphere; for the tube of a barometer equal to an inch ſquare would require fifteen pounds of quickſilver to fill it to a medium height. At this rate a middle ſized man is preſſed by 32,400 pounds all round; yet he feels it not by reaſon of the elaſtic principle of life (fire and air) in every part of the body. Preſſing equally on all ſides it does not hinder motion.

When life is at an end, another elaſtic principle (by fermentation) prevails. But then the inhaling power (by the extinction of life) being loſt, by means of the emanation continuing, and even increaſing, the body periſhes. In a ſimilar manner vegetables, and even minerals, are deſtroyed. Theſe laſt form a ruſt, which by the addition of fire and phlogiſton may be revivified to a metal again. Something like this has been *reported* of vegetables, but not *proved*.

P. 61. *The internal heat diminiſhed.*]—Thus when a drop of rain is falling from the clouds, if the air be very cold, it is frozen into hail: and water on the earth by the ſame cauſe becomes ice. In theſe caſes the internal heat is not ſufficient to counteract the atmoſpherical preſſure, and the water is compacted into a hard body. The ſize is very little leſſened becauſe water is with great difficulty compreſſed.

P. 65. *Exclude the atmoſphere.*]—On this principle may be explained all the appearances that have been aſcribed to the *attraction of coheſion*.

Thus

Thus when plaſter is laid on the ceiling of a room, the tendency in the maſs to fall to the ground is counteracted by the preſſure of the atmoſphere, provided the air is effectually excluded from between the ceiling and plaſter.

When plaſter, expoſed to the air in length of time, has its interſtices filled by ſmall particles ſuited to their ſhape and ſize; the air is more excluded, the internal parts touch one another in more points, and the whole is compreſſed to a ſubſtance reſembling ſtone.

Indeed in this way ſtones ſeem to be really made. Granite (or moorſtone) is compoſed of gravel of various ſorts and ſizes. Yet the rain in length of time, carrying into the beds of gravel ſmall bodies fill the vacuities. As theſe are filled, the air is excluded, and the atmoſphere compacts the whole into a ſolid maſs.

In the ſame manner we may conceive freeſtone to be formed out of beds of ſand: and marble from the ſoft powder of marine ſhells mixed with water in the bottom of the ſea; and compacted by the atmoſphere: when the retiring water left it expoſed to the air.

This atmoſpherical preſſure is of great advantage to worms and inſects. By this means a ſnail creeps along a ceiling, and even on a pane of glaſs. He has no claws to faſten himſelf, and if he had, glaſs could not be pierced by them. Yet he keeps himſelf from falling by applying part of his body to the ſurface, ſo as partially to exclude the air. By this means he adheres firmly by one part, till he can advance the other; ſo long as he can ſupply a ſufficient quantity of ſlime to exclude the air.

By this ſame coheſion ſpiders and flies creep on glaſs, and other ſmooth hard ſubſtances; though perpendicular, or directly over them. By the ſoft yielding ſubſtance of their feet they exclude the air, to a degree ſufficient to counteract the weight of their ſmall bodies; thus adhering alternately by their different pairs of feet. If they ſlip, the fly is ſaved by his wings; but the ſpider muſt have recourſe to his anchor and cable. He ſticks one end againſt the ceiling, and unravelling his ſilken cord, checks the fall; and aſcends by the ſame rope, or lengthens it to the floor.

According to this principle of coheſion, no adherance can exceed the preſſure of the atmoſphere, that is, fifteen pounds to an inch. And to produce this, the ſurfaces muſt be perfectly ſmooth. If two bodies (or the different parts of the ſame body) cohere with greater force than this, it muſt be owing to ſome other cauſe, ſuch as the parts being woven together, as in timber. But to ſay this is owing to *attraction* is an evaſive way of ſaying, I know not 'the 'cauſe.'

P. 63. *On the ſame principle.*]—In this way (partly) it is that the ſap riſes in plants and trees. They are ſupplied with capillary tubes turning in different directions; and, probably, have valves at different diſtances, with various other proviſions beyond our ſearch; by which the nutritious juice is raiſed higher than a ſingle preſſure of the atmoſphere could lift it. They muſt have alſo a variety of glands (or an apparatus ſomething ſimilar) to ſeparate and prepare the different ſorts of fluid; and tranſmit each ſort to its proper place in the wood, pith, bark, leaves, fruit, and the different parts of each of theſe.

In all this there is nothing that can be expreſſed by *attraction*; but a complication of *powers*, that are beyond the reach of human ſkill, manifeſting infinite Wiſdom and almighty Power; as well as adorable Goodneſs towards them for whom this proviſion is made. Indeed the principle of life (either animal or vegetable) is hidden from human ſearch, and is probably cauſed either immediately by The Almighty himſelf, or ſome intelligent agents acting by his direction. But ſome of the inferior material agents may be diſcerned, and theſe are properly the objects of philoſophical reſearches. And in the preſent caſe of vegetation, it is obſervable that its effects are greateſt in the ſpring; when the ſolar rays, falling more direct, become more powerful; and the united force of Sun and Moon raiſe the ſap at the ſame time, as they lift the tides in the ſpring equinox. The effect continues during the ſummer's heat (another effect of the ſame cauſe) but no new effort is made till towards the autumnal equinox: when the ſame cauſes, that raiſe the tides, produce a ſimilar effect in vegetation; but this is ſoon checked by the winter's cold.

Some have made obſervations on the changes of the Moon, as attended by ſimilar correſponding changes in vegetation. In America they prefer felling oaks in the Moon's laſt quarter; becauſe then they are moſt eaſily ſtript of their bark. Perhaps the ſuperior power of the Full Moon requires ſome days to have its effect on the riſing ſap.

P. 65. *Drawn towards the wall.*]—In the experiment made near a mountain in Scotland, this is ſaid to have been the caſe, in a very ſmall degree. To account for which, without attraction, it may be obſerved that the emanation, often mentioned, proceeds from every part of the Earth. Of courſe the influx or reflux muſt be directed towards every part to ſupply the vacuity. And all moveable bodies impelled by it muſt partake of this direction.

P. 69. *No ſuch cauſe exiſts.*]—It may then be aſked, What is the reaſon that the corks move towards each other?

If this queſtion could not be anſwered here, it would not follow, that it was *unanſwerable*: there are many things *knowable* that are not yet *known*.

The experiment of the corks ſucceeds when they are dry or wet; but upon different principles. When they are dry, the water round them ſeems to be depreſſed; and when the cavities made by this preſſure are joined by the corks being placed (or moved by a current of air) near each other; they fall together by reaſon of the lateral preſſure of the water being greater on the outſide than between them.

When they are wet, the water is accumulated round them, and when the two accumulations come near, they ruſh together on the ſame principles as two drops of water unite.

If it be aſked, Why the *dry* corks form a cavity round them? that will be conſidered, when we come to ſpeak of *repulſion*. If the reaſon be demanded, Why water riſes round the wet corks, and why the two accumulations unite? this will be conſidered now:

Coheſion takes place only between bodies that are ſo ſimilar in their nature, or ſo ſuited to each other, as to admit of their parts to come into contact:* and in proportion to this contact, the coheſion is greater or leſs. Where there is no contact, the air ſurrounds the body, and, if it be a fluid, forms it into a globular ſhape.

Thus

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* It is aſſerted (and ſaid to be proved) by modern chymiſts, that no two particles of matter touch each other. This may be true. They may be ſeparated by that efflux and reflux to and from the heavenly bodies which is the great agent in producing gravity and other effects aſcribed to *attraction*. But when we ſpeak of *contact*, we mean that no viſible object intervenes.

Thus quickſilver dropt on a table does not appear to touch it, by reaſon of the diſſimilarity in the conſtituent parts. Water falling on any thing that is oily, or very dry earth, or on a dry leaf, does the ſame. It is preſſed by the atmoſphere into a globular form. But when two drops of quickſilver, or of water come into contact, they unite immediately. This brings the two accumulations round the wet cork into one. And thus the water, in which they ſwim, ſlides eaſily into contact with the water that is about them.

P. 66. *Elective attractions.*]—In chymical experiments we ſee much of what is called *elective attractions;* but every thing may be explained without ſuppoſing any ſuch thing. By a proper menſtruum, penetrating the pores of bodies, the internal fire is agitated. This cauſes them to throw off an emanation; and this emanation being received by another body, whoſe pores and inward frame are peculiarly ſuited to it, the effect is a total diſſolution, like that which happens in bodies ſet on fire: for ignition is nothing but ſeparation. And when this active fire is ſpent or becomes latent, the diſſolved parts adhere, by the preſſure of the ambient fluid, in a form ſuited to the texture of the diſſolved particles, in various chriſtallizations.

P. 67. *Keep other bodies at a diſtance.*]—Thus all the heavenly bodies ſeem to have a principle of ſelf-defence, in their reſpective emanations. Theſe going off with great velocity repel all other bodies; and their ſecurity is the greater, becauſe the power of this repelling emanation increaſes, as the ſquares of diſtances from the repelling body decreaſe. This may ſecure us from all apprehenſions of the Earth or Moon falling into, or drawing nearer to the Sun: as ſome have imagined. On the other hand, if the heavenly bodies had been governed by attraction, we ſee no proviſion for preventing ſuch effects; eſpecially when they came ſo near each other as to diſturb and alter each other's motion. According to the ſyſtem of attraction, the nearer they approach, the ſtronger is their propenſity to unite. But according to this ſyſtem of *Coſmology*, the nearer they approach, the greater the energy to keep each other at a diſtance.

P. 67. *Electrical attraction.*]—It is certainly more intelligible to ſpeak of bodies carried to and fro in electrical currents of the exiſtence of which we have clear evidence by the eye and the touch; than to talk of bodies loſing their electricity, and then coming back (like hungry animals) to be filled again. When once a notion is entertained of attractive powers acting at a diſtance, no opinion is too ſtrange to be admitted: but in electricity there is no need to multiply wonders without proof, nor make them more wonderful, by the language in which they are expreſſed. The real operations are ſufficiently marvellous.

It is clear beyond all poſſibility of doubt, that this fluid penetrates all bodies with eaſe and efficacy; except thoſe that are themſelves electrical: and theſe have a power of receiving the fluid from the atmoſphere as long as they are warmed by friction, and rejecting it when offered by electrified bodies.

P. 68. *Appears from the effects.*]—Some of theſe effects are of great ſervice to the human body, others very hurtful; as appears from the accounts of Cavallo and others.

A very reſpectable Clergyman, whoſe age is nearly midway between eighty and ninety, told me, he had by the electric ſhock removed a ſpeck (he called it a pearl) from his eye, that threatened blindneſs.

Another Clergyman aſſured me, that by a ſingle electrification, his Friend had been cured of a violent inflammation in both eyes, of a long continuance, after many other means had proved ineffectual.

'There is no body in nature that is not 'acted upon by electricity, either as a con'ductor or nonconductor. Several fiſhes 'poſſeſs the property of giving the electric 'ſhock. The torpedo, or numbing fiſh; 'and one or more ſpecies of eels, from 'Surinam, if touched by the hand or me'tal rod, or any other conductor, give a 'conſiderable ſhock, but may be ſafely 'touched by means of a ſtick of ſealing 'wax. The ſhock depends on the will of 'the fiſh, and is tranſmitted to a great 'diſtance, ſo that if perſons in a ſhip hap'pen to dip their fingers or feet in the ſea, 'when the fiſh is ſwimming at the diſtance 'of fifteen feet, they are affected by it.' *Nicholſon's Introduction.*

This is wonderful but not incredible, becauſe we can conceive a ſubtil flui[illegible]

netra[illegible]

netrating through water, air, or earth, or any other body. But one body acting on another without contact, mediate or immediate, is inconceivable.

Theſe examples ſhew that the electrical fluid can paſs through the body imperceptibly, yet ſo as to impel and produce great effects. Theſe are the two powers (penetrating and impelling) which have been pleaded for, as belonging to the ſolar rays and other emanations, as equal to the effects expreſſed by *attraction*: a thing inconceivable without a continual miracle; that is, without ſuppoſing THE ALMIGHTY to work in a manner, of which all the works of creation and providence afford no other inſtance. On every other occaſion means are uſed equal to, and fitted to the end.

P. 75. *The Earth is full of Thy riches, ſo is the great and wide ſea.*]—We ſee a little only of the internal ſtructure of the Earth, and ſea, and their contents. But is there no eye admitted to behold theſe wonders but that of HIM that formed them? Are there no Beings capable of knowing the power and wiſdom diſplayed [illegible] bowels of the Earth, and in the [illegible]ths of the ſea? And if ſpirits ſee and admire, being active and intelligent, may they not be employed in various operations ſuited to their powers, not only here but in all parts of the creation? As ſar as we ſee, THE ALMIGHTY works by means ſuited to the end; may not ſome of theſe means be active and intelligent agents?

This was part of the moſt ancient philoſophy, and is entirely agreeable to the Holy Scriptures; where ſpirits of different diſpoſitions are repreſented as acting all under the direction and permiſſion of THE UNIVERSAL LORD. Indeed, without this ſuppoſition, it will be difficult to aſcertain the meaning of ſome expreſſions we frequently meet with; ſuch as the *laws of nature*, and the Divine Government being regulated by *general laws*.

For to whom are theſe laws ſuppoſed to be given? If to the inanimate parts of the creation, the language is merely figurative, and ſignifies no more than, that God himſelf produces the effect by inſtruments, which he has prepared for that purpoſe. But this is not always the meaning of thoſe expreſſions: eſpecially when we hear perſons ſpeaking of the *feeble efforts of nature*; where the end is not accompliſhed, that ſeemed to be intended. THE ALMIGHTY cannot be deficient in power, nor THE ALL-WISE be diſappointed in his purpoſes. Yet we often ſee (in ſeeds of plants and previous ſteps towards the production of animals) a wonderful proviſion made for producing effects, which however, by means of ſome ſeemingly accidental circumſtance, are totally prevented, and never compleated.

The truth is, the words *nature* and *laws of nature* are frequently uſed without any determinate meaning, and as ſerving to exclude all regard to Him who is the Author of what is called *natural*, and Director of all that is called *accident* or *chance*.

He is the *Great Lawgiver*, but to whom does He give his laws? Not to Beings incapable of underſtanding, and conſequently of obeying him. Intelligent agents are alone capable of receiving commands: And if they are free agents, they may be permitted to diſobey them. We ſee this daily among men, and why may it not be the ſame in the world of ſpirits? They are deſcribed in God's Word as good and bad, and acting according to their different diſpoſitions; yet always limited by the Supreme Being, on whom they, as well as men, continually depend. On Earth men are benefactors or injurious to one another according to their different characters. And if we ſuppoſe ſpirits to be permitted to act as freely, this will account for a number of defects which otherwiſe are unaccountable, and will point out the origin of many evils, which otherwiſe elude all inquiries. But this inveſtigation would lead us beyond the regions of *phyſicks;* and can be purſued with ſafety only by attending to what *God* hath revealed in the written Word.

There we learn, concerning ſome ſpirits, that when God created the world they *ſhouted for joy*, Job 38. 7. We find them employed as God's ſervants for the benefit of his people; attending on Christ, Prophets and Apoſtles; as the guardians of particular countries, and of little children; as *miniſtring ſpirits ſent forth to miniſter to them that ſhall be heirs of ſalvation.*

Of others we read that they are inſtrumental in bringing ſin into the world, and death by ſin: as permitted to afflict good men for the exerciſe of their faith and patience, ſuch as Job and others: and deſiring to *ſift them as wheat;* as *lying ſpirits in the mouth of falſe prophets;* as poſſeſſing the bodies of men and grievouſly tormenting them; as *filling men's hearts to ſpeak lies*, and *ruling in the children of diſobedience;* as *the rulers of the darkneſs of this world*, ſo that wicked men are cut off by the laws as confederated with them, and '*moved by the inſtigation of the devil.*'

By the feudal laws, (from which many of our own are taken) no crime ſeems to have been puniſhed by death, but treaſon. On this account, when it appeared neceſſary to inflict a capital puniſhment on other crimes, men were ſtiled rebels againſt GOD and our ſovereign lord the King. But theſe were not mere *fictions*, but founded in fact. Great and continued crimes indicate a ſtate of rebellion againſt the king or executive power, and againſt the king of Kings.

Such active beings, ſo intimately connected with the things of this world, may be reaſonably ſuppoſed, according to their different characters, and as commanded or permitted by the *almighty God*, to be agents or inſtruments in much of the good and evil that befals us.

In fact the Holy Scriptures are the ſureſt teſts of truth in all caſes where they give us any information. By them therefore let us try this whole ſyſtem, which is the ſubject of the preſent inquiry: let us examine whether the account given of the creation in the book of Geneſis will confirm what is here attempted to be proved and illuſtrated.

Gen. chap 1. v. 1, &c. *In the beginning*, previous to the work of ſix days, *God created the Heaven and the Earth.* He formed or gave being to all things that exiſt; but we are not told *when* this was done. The Heaven, the Sun and ſtars, might have exiſted long before; and ſome of the planets, or even all might long have moved round the Sun.

Indeed the Earth itſelf might have had a pre-exiſtent ſtate of beauty; but immediately previous to the ſix days of creation, it is deſcribed as *without form and void, and darkneſs was upon the face of the deep.* It ſeems then to have been a maſs without form, without productions, dark, and (from the waters afterward mentioned) moiſt.

To remove theſe defects, and bring into beauty and uſefulneſs this unformed maſs, it is ſaid, (v. 2.) *the Spirit of God moved upon the face of the waters.*

By *the Spirit of God* ſome have ſuppoſed the Holy Ghost to be here meant. But, He is ſuppoſed to have been already ſpoken of in the firſt verſe, as included in the word God; *The Elohim He created the Heaven and the Earth.* The Spirit of God here ſpoken of might be either ſome inferior agent, or inſtrument; acting under, and by the direction of the Elohim.

Accordingly others have thought that by the *Spirit of God* is here meant the air, acting with great energy; and on that account ſo called; as we read of *trees of God.* But the air is a cauſe ſcarcely equal to the effect produced, the removal of *darkneſs* and *moiſture* by light and fire, making that beautiful which was *without form;* and that fruitful which was *void* and deſolate. But the ſolar efflux, (that divinely powerful ſpirit of fire, light, and heat) ſeems fully adequate to the great effect, when directed by almighty Power and unerring Wiſdom. This might well be called *the Spirit* (or breath or blaſt) *of God*, becauſe it was ſent by Him, as the great inſtrument in the work of creation, and in preſerving in well-being the works of the Creator.

Accordingly the Pſalmiſt aſcribes theſe to the ſame agent, Pſ. 104. 30. *Thou ſendeſt forth thy Spirit, they* (the animals) *are created: Thou reneweſt the face of the Earth*, reproducing plants in ſpring by the ſame power. And Pſ. 33. 6. *By the word of the Lord were the Heavens made; and all the hoſt of them by the breath of his mouth.* It is true theſe may be figurative expreſſions, implying only that the creation at firſt, preſervation, and annual renewal, of the Earth and its furniture, is by God's power and command. But if we can diſcover a literal propriety in theſe expreſſions, it adds a beauty and force to the language, by diſcerning an accuracy in the words, not before remarked.

Of this *Spirit of God* it is ſaid *that he* MOVED *upon the face of the waters.*

The word tranſlated *moved upon*, happily expreſſes the divine energy aſcribed to this powerful agent. It ſignifies *to hover over*, as a bird over her neſt; communicating warmth and infuſing life. Such is the powerful operation of the ſolar efflux on the Earth itſelf, and the ſeas; whereby they are ſtocked with inhabitants, in the manner afterwards deſcribed.

But the firſt effect is thus deſcribed, v. 3, *God ſaid Let there be light; and there was light.* Let an emanation from the Sun reach the unformed maſs, *move on the face of the waters*, ſo as to raiſe them by rarefaction to an atmoſphere, and make way for light to be diffuſed over the whole. In obedience to the Divine Will, *there was light.* Not that it was then created; but in that inſtant had its effect on the dark maſs. For that the Sun was created before is highly probable from the mention of the Heaven in the firſt verſe; and becauſe it does not appear how there could be light without the Sun. When therefore two great lights are mentioned for the firſt time, in the account of the work of the fourth day; this *may* only imply that then the Sun and Moon firſt *appeared.* The Moon indeed might be then *made*, or, being an appendage to the Earth, might be gradually formed with her primary planet; but the Sun and ſtars, though then firſt mentioned, probably exiſted long before.

It is added, (v. 4.) *God ſaw the light that it was good, and God divided the light from the darkneſs.* By turning the Earth round its axis, day and night followed each other.

As this Spirit of *God* (or ſolar emanation) thus moving upon the face of the watery maſs produced light, it ſeems alſo to be the great agent in producing all the other effects, that are deſcribed in the reſt of the chapter. By rarefaction part of the waters were raiſed, and the ſpace between theſe, and the waters that ſtill remained condenſed, had the appellation of the *firmament*.

By the ſame agent *the waters* that remained *under the Heaven* (or firmament) might be *gathered together into one place* called *ſeas*; impelled, by the ſtroke of the ſolar rays, into the hollows prepared for them; and by their retiring *dry land appeared*. v. 9, 10. The ſame might be the inſtrument in cauſing the Earth to *bring forth graſs, the herb yielding ſeed*, and the *fruit-tree yielding fruit*. v. 11. By the ſame means might the waters be enabled to bring *forth the living creatures*. v. 21. and the Earth to produce the cattle and creeping things. The efficient cauſe of all theſe was *God* himſelf; of whom it is ſaid, God *created great whales and every living creature that moveth*. The material cauſe was the Earth and water and other elements; but the *ſpirit of* God moving on and impregnating, as mentioned at firſt, ſeems to be a powerful under-agent in creation, as afterwards in moving and preſerving all. At leaſt the words will admit of this explication. It is not here contended that this is certainly their meaning. When the creation of man is deſcribed, the phraſe is altered: *Let us make man in our image.* To whom did God ſpeak *this?* Not to the angels, for though they might have been employed as under agents, there is no intimation of this. Certainly they were not conſulted, for *who hath been the counſellor of* God? This expreſſion therefore (compared with the plural *Elohim* in the firſt verſe) ſeems to be an intimation of what was afterwards more clearly revealed; that creation was not the work of the Father only but of the Son alſo: of Whom it is ſaid, *all things were created by Him.* To Whom therefore, with the Father and Holy Ghoſt, *who ſearcheth the deep things of* God, be glory for ever.

APPENDIX,

CONTAINING

FOUR DISSERTATIONS

TENDING TO

ILLUSTRATE AND PROVE

THE

PRINCIPLE OF THE PRECEDING ESSAY.

APPENDIX, &c.

DISSERTATION I.

Of the tides, currents, and winds.

IF the theory of the *tides*, propoſed in the preceding eſſay, is well founded; it will explain the various phænomena, at leaſt it will not be inconſiſtent with them. Let us examine whether it be ſo, or not.

I. As the Earth moves round its axis in twenty-four hours, if the tides be influenced by impulſe of the ſolar and lunar rays, they will correſpond to the approach of different places to, and their receding from the Sun and Moon. This is known to be the caſe.

II. As the diurnal motion of the Earth is from Weſt to Eaſt, and in conſequence the apparent motion of the Sun and Moon is from Eaſt to Weſt; if tides be the effect of impulſe they will move in open ſeas from Eaſt to Weſt. The current of waters and the current of air will, where not affected by local interruptions, move in this direction: every part of the ocean and atmoſphere being kept down, as they approach the impelling body. Accordingly we find that within the tropicks (where the Sun and Moon act moſt powerfully, being vertical, or nearly ſo) there is an almoſt conſtant current of air and water from Eaſt to Weſt.

III. Let us ſuppoſe the Moon (or Sun) to be vertical, at any time, ten degrees Weſt of the Coaſt of Africa. The effect (according to the ſyſtem of impulſe) will be to cauſe the waters to retire every way. But this effect is for a little time.

When, by the apparent motion, the place of the Moon (or Sun) is ſome degrees farther weſtward; the waters will return to the former ſituation; and, as the luminary moves weſtward, will flow in that direction, to reſtore in *ſucceſſion the equilibrium, deſtroyed by the vertical impulſe. Thus is produced a current of water and air (for the †luminary affects both) towards the Weſt, directly under the line;

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* This reſtoration of the equilibrium in water and air is the effect of the equable preſſure of the radii of the ſtars, planets, and ætherial reflux. Theſe (except a ſmall difference with reſpect to the nearer and larger planets) are in general the ſame. And were this the caſe with the Sun and Moon alſo, they would cauſe no change in the water and air. But being near, large, powerful, and always changing their apparent poſition with reſpect to the Earth, and each other, hence ariſe the changes in the tides and currents.

† The luminary affects both, but not alike, nor with the ſame effect, on account of two properties in air not found in water; *elaſticity* and *compreſſibility*. Water cannot be *compreſſed*, but air is eaſily reduced to occupy a ſmaller ſpace. When thus reduced it becomes more *elaſtic*, and finds a way to eſcape either laterally, or, if confined, upwards; till it finds a region ſuited to its ſpecific gravity: and in that region it expands into a larger volume in proportion to its height above the Earth.

Had it not been for theſe two properties in air, the Moon would affect it in the ſame manner as the water; and the barometer would riſe as many inches, as the ſea riſes in the number of feet, at high water.

It has been obſerved of late that the impulſe of the Moon does affect the barometer; but in a very ſmall degree. A periodical riſe and fall has been obſerved of a few lines correſpouding with the tides. The greateſt variations are owing to other cauſes. Theſe remarks will help us to explain two phænomena: the ſmall variation of the barometer in hot countries, and the effect of a clear ſky in raiſing the quickſilver. In hot countries the air greatly rarefied finds its way quickly upwards and ſpreads abroad without raiſing the barometer much. But by the act of expanſion, preſſing every way, it does raiſe it a little more than when the ſame quantity of air is loaded with watery particles; ſo as ſcarce to be held in a ſtate of ſolution.

ſuppoſing the Moon or Sun to be there. But on the North ſide the current and wind will be from the north-eaſt; on the South ſide from the ſouth-eaſt.

IV. Experience ſhews that this is really the caſe; but this effect has been aſcribed to rarefaction by the Sun's heat.

The effect of rarefaction is to expand and raiſe both water and air, which aſcend, in conſequence of their becoming ſpecifically lighter, by being forced upwards by denſer air and water, ruſhing into the places which they occupied before. And this rarefaction, by the vertical Sun, is certainly the cauſe of the lightning which uſually prevails, ſoon after noon, near the line: the expanded air drops its water in rain, and the electric fluid eſcapes in lightning. But this does not at all account for the conſtant flow of air and water towards the Weſt. This muſt be the effect of regular impulſe in that direction; in the ſame manner as any floating body drawn through water, will cauſe a current the ſame way; and if a ſucceſſion of floating bodies move thus, there will be a conſtant current.

V. In fact rarefaction is itſelf the effect of impulſe. When we conſider the immenſe velocity with which light (the ſolar efflux) moves, and conſequently the many millions of impulſes made every ſecond of time (ſuppoſing the rays divided into ſmall portions in length;) by rays of light immeaſurably ſmall, inſinuating themſelves between particles of air and water, theſe particles muſt be hereby ſeparated; that is, the whole expanded or rarefied.

But, in producing currents of air or water, the operation muſt be principally by impulſe: becauſe had it been by rareſying heat, the effect would be produced only by the Sun: whereas it is well known that in producing currents or tides, (for tides are regularly changing currents) the Moon is the principal agent: whoſe heat (and conſequently her rarefiying power) is imperceptible.

VI. In the regular current and trade-wind, rarefaction regularly co-operates with impulſe; but where lands are near, this regularity is interrupted, by the rareſying heat of the Sun prevailing in different places at different ſeaſons. In this way are produced the *monſoons*.

When the Sun is in the equator or ſouthern hemiſphere, in the Indian Ocean, the winds blow from Eaſt to Weſt, (or from ſouth-eaſt to north-weſt) for the ſame reaſons as the trade winds in open ſeas blow in that direction. But when the Sun advances towards the northern tropick, the heat becomes greater under and near that tropick, than under the equator. The reaſon of which is this: the northern tropick paſſes over land chiefly from the Cape of Good-Hope to the South of China; but the equinoctial in the ſame longitude almoſt entirely paſſes over ſeas. But ſeas are not heated ſo much as lands, and of courſe do not ſo much contribute to heat the air above them. While therefore the Sun is in the northern hemiſphere, the direction of the air between the equator and northern tropick, will be towards the North. But if it be aſked, What occaſions its tendency eaſtward? (for in the ſummer months they blow towards the north-eaſt) this may be explained on the ſame principle as the general prevalence of weſterly winds without the tropicks in the two great oceans. Theſe are eddies cauſed by the conſtant current of air and water weſtward under the equator and near it.

VII. Thus in the Atlantic the current reaching the Continent of America is repelled, ſo as to cauſe a double eddy:

One part turning towards the North conſtitutes the *gulph-ſtream.* That part of the current, which flows towards the South, goes along the eaſtern ſide of South America, until it approaches Cape Horn.

The equatorial current (of air and water) being thus repelled by the land, and turning North and South, in latitudes without the tropicks might be expected to move in a contrary direction to *reſtore the equilibrium. Accordingly we find that without the tropicks weſterly winds and currents generally prevail; but not with that uniformity obſerved within the tropicks.

VIII. The *trade-wind* after croſſing the Atlantick is interrupted by the Coaſt of America. There the upper part of the atmoſphere will paſs over the continent into the Pacifick Ocean, with ſome variety in its direction ariſing from hills and vallies. The lower part will flow along the eaſtern coaſt to the North and South, in the ſame direction as the *current.* That

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* This general tendency of waters towards a level may be conceived to be the general effect of the combined impulſes of all the heavenly bodies united. Theſe keep down the atmoſphere, and in conjunction with it preſs down the ſeas. As this is the effect of many powers acting together, this would cauſe an univerſal level of waters. But this effect is prevented partly by the irregularity in the rarefaction of the air producing winds: and partly by the regular changes of the lunar and ſolar impulſe producing tides.

which reaches the Straits of Magellan and Cape Horn encounters the wind and current from the Pacifick: and with it turns towards the eaſtward.

In the ſame manner, that part of the trade-wind, which is turned by the eaſtern coaſt of America towards the North, partly falls in rain, or ſnow, or fogs; and partly turning eaſtward (in the grand eddy counteracting the tropical winds weſtward) occaſions the prevailing winds and rains from the Weſt, experienced by the northern inhabitants of Europe. Indeed a French philoſopher aſſerts that at a certain height above Paris the wind is always weſterly. It may be ſo in general in the neighbouring countries at a great height: and when it blows in a different direction below, this may be effected by the obſtruction of high lands.

IX. In the *Pacific Ocean* there is the ſame current and trade-wind within the tropicks as in the Atlantic; and the ſame diviſion of air and water on the eaſtern coaſt of Aſia; by which they are turned, part towards the North, and part towards the South.

The water turning towards the South in the Pacific Ocean makes an eddy towards the Eaſt; and then part of it will come round towards the equator to reſtore the equilibrium, deſtroyed by the current weſtwards between the tropicks; and by the plentiful exhalation in that warm region. Another part of the waters flowing eaſtward, in the ſouthern part of the Pacific, will continue in the ſame direction, and paſſing to the ſouthward of Cape Horn will flow on in the Atlantic, and continue the current round the globe, between the ſouthern Capes and the South Pole.

X. And this may help to account not only for that wind and current towards the Eaſt, ſo univerſally prevailing ſouth of the tropick, in the ſouthern hemiſphere; but alſo for the greater degree of cold in the ſame region, above that which is experienced in the northern hemiſphere, in the ſame latitude. In the ſouthern parts of both oceans part only of the water, deflected from the equatorial regions, returns back again to that warm climate from whence it came. The reſt, continuing its eaſtern courſe, without interruption, between the ſouthern tropick and South Pole, at a diſtance from the Sun, ſtill retains its cold.

On the other hand the water, deflected towards the North in both oceans, finds no opening towards the Eaſt; and when accumulated to a certain degree, muſt fall to the ſouthward; and joining again the equatorial current has its loſt heat reſtored. This is owing to the junction of both continents towards the North, which are ſeparated towards the South.

XI. In both oceans the effect of the Sun and Moon, acting together in the ſpring tides, is reckoned to be a difference of about twelve feet between high and low water. In narrow ſeas and channels the difference will be greater or leſs according to local circumſtances. When the flood opens with a wide mouth into a river growing gradually leſs, the water thus confined will riſe high: as in the river St. Lawrence, and the Briſtol Channel. Where it enters by a narrow mouth into an inland ſea growing wider, as the Mediterranean, the force of the tide will ſoon be ſpent and riſe but little.

XII. The trade-wind, the current of water, and the tides are conſidered together, becauſe all are produced by the ſame ſolar and lunar impulſe. But theſe ſhould be conſidered ſeparately alſo.

The trade-wind is a portion of the air or atmoſphere, raiſed by evaporation from the ſea, and impelled by the Sun and Moon weſtward; till mingling with the reſt of the atmoſphere, it is driven in various directions, and at laſt, condenſed into rain, falls again into the ſea; or if it falls on the land, becomes a bleſſing to the country by watering the Earth, and then returns in rivers to the ocean.

The *current* is a ſtream impelled by the ſame cauſe. And by the *tide* is meant the variations in this current, according as the impelling powers act ſeparately or in conjunction.

The current may be traced from the middle of the Atlantick to America, and from thence back in the northern hemiſphere to Europe. And by this current, we are informed, the productions of America have been carried to the coaſt of Norway; ſuch as nuts and pieces of wood.

The *tides* are different from the current, they move much more rapidly. They are not the ſame particles of water, but are cauſed by an effect of impulſe, communicated from one part of the great body of waters to another; as in the concuſſion produced by a diſtant earthquake. This is the effect of that quality in waters, by which they are incapable of being compreſſed. They eaſily give way to impulſe, and by impelling the waters near them, communicate the motion very quickly.

XIII. The time, taken up in communicating this impulſe of tide in the open ocean, may nearly equal the apparent motion of the luminaries by which it is effected. But when the direction is altered, it probably becomes gradually ſlower. And after various deflections, the time of the flood may be *traced in narrow ſeas; but with great inequality owing to promontories, ſhoals, and ſunk rocks. In the two oceans the effects are produced with great regularity.

For inſtance—at the time of New Moon ſuppoſe both luminaries to be on the firſt meridian, their united emanations keep down the waters where they are vertical, and where their radii fall perpendicular, with

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* When the Moon is one or ſixteen days old, it is high water at Scilly and

	h.	m.
at the Lizard	6	3
At Plymouth	6	40
The Start	7	33
Southampton	12	48
Downs	2	18
London	3	48

with the greateſt force; which is leſſened gradually till, at the diſtance of 90 degrees, it is entirely ſpent. For more than half the globe can never be preſented to the ſame impulſe at the ſame time. At 90 degrees diſtance then there will be high water, and a ſpring tide in the 90th degree, and in the 270th degree.

At the ſame time, on the oppoſite ſide of the globe, the lunar and ſolar reflux will act together, and produce the ſame effect: that is, low water in the 180th degree, and high water with a ſpring tide, in the 90th, and the 270th: where the flood, produced by the lunar and ſolar reflux, will unite with that produced by the lunar and ſolar efflux.

At the time of the Full Moon, the ſame effects will be produced by the ſame powers, acting in oppoſition. If we eſtimate the lunar efflux to be five, and the ſolar three; when they are together their joint power will be equal to eight. So when they are oppoſite, as at the Full Moon; ſuppoſing their reflux to be equal to the efflux; in this ſtate the lunar efflux, equal to five, acting in the ſame direction as the ſolar reflux, equal to three, the effect in keeping down the waters, where the Moon is vertical, will be here alſo equal to eight. Of courſe there will be high water in the 90th and 270th degrees, as at the time of New Moon.

At the ſame time, on the oppoſite ſide of the globe, in the 180th degree of longitude, the Sun being vertical acts with three degrees of power, and the lunar reflux, always equal to the efflux, being equal to five; here alſo will be low water at the ſame time. And at 90 degrees diſtance, Eaſt and Weſt, the waters not being preſſed down by either luminary, will riſe to a ſpring tide.

At the time of the quarters the power of the Moon, equal to five will be leſſened by the power of the Sun, equal to three. Of courſe, the effect in keeping down the waters will be equal to two: and the flood at 90 degrees being in proportion, it will be neap tide.

On the oppoſite ſide of the globe, the ſame effect will be produced in the 180th degree by the lunar reflux, equal to five, leſſened by the ſolar reflux, equal to three: for in this ſituation the Sun and Moon, being 90 degrees diſtant from each other, act in different directions: and the Sun keeps down that flood which the Moon raiſes.

It is not here aſſerted that theſe are the exact proportions between the powers of the Moon and Sun; but round whole numbers are uſed for greater clearneſs.

In all other ſituations the effects produced by the two luminaries, will be greater or leſs according as the radii of the Sun fall leſs or more oblique to thoſe of the Moon; and as they approach nearer to, or recede farther from the poſitions which produce the greateſt or leaſt effect.

Low water being always produced either by the vertical Moon, or by the vertical direct impreſſion of the reflux towards the Moon, it will be low water twice in twenty-four hours under every meridian ſucceſſively, as, by the Earth's rotation, every degree of longitude is brought under the vertical Moon or to the point 180 degrees diſtant, under the direct impulſe of the lunar reflux. And the high water being always at 90 degrees diſtant from theſe two points, it muſt be high and low water twice in twenty-four hours, all round the globe in ſucceſſion. This the theory leads us to expect; and this experience conſtantly confirms.

DISSER-

DISSERTATION II.

On the effects of earthquakes.

AN exceſſive accumulation of fire in the human body may be conſidered as a cauſe of fever, and many other diſorders. And in the ſame manner too great a quantity in the bowels of the Earth produces earthquakes and volcanos.

Theſe are ſevere calamities, but like the operations of divine Providence in other caſes, (who in wrath remembers mercy) theſe are often attended with beneficial conſequences.

From the great number of volcanos ſtill burning, and many others, where the effects are viſible, though the fire is not ſo at preſent; it is certain that in the bowels of the Earth are vaſt caverns of fire. Some of theſe have a communication, as appears from the mutual effects which they cauſe on one another: one volcano being quieted by the diſcharge from another not far off. Some of theſe internal fires lye very deep, and are very extenſive, as appears from their moving a large portion of the Earth at the ſame time.

From theſe vaſt elaboratories iſſue fire, vapors of various qualities, and the different ſorts of burnt and fuſed ſubſtances, that compoſe the volcanic mountains, and cover the lands about them. In themſelves theſe are inſtruments of wrath uſed for the chaſtiſement of ſinners: for without ſin there is no death nor any of its harbingers; nor does either good or evil befal us without Divine appointment. But though in themſelves judgments, yet in their conſequences they are beneficial. The lands are made fruitful by the aſhes diffuſed; the very lava in time produces vegetables, and in its hardened ſtate is ſubſervient to various *uſes. The very inequalities produced by theſe eruptions are favorable to the production of many uſeful trees (particularly the vine and olive) which would not otherwiſe be ſo well ſheltered. By theſe means

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* In Holland, where ſtones are very ſcarce, the want is ſupplied by the quarries on the Rhine; which the ingenious Mr. Luc has proved to be formed by volcanic eruptions, at a time when theſe countries were covered by the ſea: for over theſe quarries are ſtrata of marine ſubſtances.

means the Andes and Ætna enjoy the different ſeaſons together.

Among the other effects of earthquakes and volcanic eruptions, it ſeems probable that theſe have been employed in preparing various minerals, and depoſiting them in places within the reach of man; when ſought with laborious diligence, which is itſelf a great bleſſing; as it ſupplies employment and maintenance. When we obſerve the ſituation of the loads of metals; found in narrow fiſſures of an indefinite length, and ſeldom failing in depth, it is highly probable that theſe ſtores were lodged there, under the direction of the Almighty, by ſubterraneous convulſions. Small quantities of metals are ſtill found ſcattered in the Earth; and, by a ſtream of water waſhing away the lighter earth, are ſtill prepared for the ſmelter. But if in ſome of thoſe ſubterraneous fires, of which almoſt every part of the World retain ſome marks, ſome of the minerals have fallen into the immenſe furnace; they might be thrown into thoſe clefts, produced by the ſhaking of the Earth where they are ſtill found.

The ſubterraneous caverns of which Ætna, Veſuvius, and the Lipari Iſlands have been for ages the ſmoaking outlets, muſt be very great, in conſequence of the vaſt quantities diſcharged from them. The hollows from whence the Andes have been raiſed muſt be ſtill greater. Theſe examples ſhew that it is not improbable, that the tradition, of a continent or vaſt iſland ſunk in the Atlantic may be founded in fact. Indeed the iſlands ſtill remaining with the volcanick peaks, and the appearance of the adjacent countries make it highly probable.

If we ſuppoſe this great event to have taken place at the time of the deluge, it will at once explain the ſacred hiſtory, and account for many appearances in different parts of the globe.

If the ſubſiding of the Atlantic continent, into the grave prepared for it, was gradual, taking up the ſpace of an year; this might be the year of the deluge. When Earth and ſea began to fill the vaſt cavern, the mixture of fire and water would produce a vapor to fill the Heavens with watery clouds, attended with lightning, ſtorms, and tempeſt; as much greater than thoſe which attend the eruptions of Veſuvius, as the ſtorehouſe from whence they poured was larger. Then, as Moſes writes, *were* *all the fountains of the great deep broken up, and the windows* (or flood-gates) *of Heaven were opened.* And theſe two ſources were abundantly ſufficient to cover the Earth. Gen. 7. 12. *The rain was upon the Earth forty days and forty nights.* During this time the flood-gates of Heaven diſcharged their contents. But the ſupply of waters from *the fountains of the great deep now broken up* continued longer. By theſe means the waters ſtill continued to increaſe. v. 24. *The waters prevailed upon the Earth* (continued to riſe) *an hundred and fifty days.*

As the Atlantic region deſcended, the waters whoſe place it then occupied, muſt riſe of courſe, and overflow the land; and if this deſcent was ſuch as to be one hundred and fifty days, before it ſunk ſo low as for the waters to cover what was land before, and form what is now the Atlantic Ocean; ſo long would the waters continue to increaſe upon the face of the Earth. But when the deſcending continent ſunk lower, and the waters flowed over it to a conſiderable depth, the effect muſt be that the waters that were raiſed above the Earth would retire; and continue to abate till the ſubmerged continent reached the depth prepared for it. *God made a wind to paſs over the Earth and the waters aſſuaged.* By this wind the waters were driven to the place appointed for them, making that ſea, which was land before. Now too, both the great ſources of water ceaſed. Gen. 8. 2. *The fountains alſo of the deep, and the windows of Heaven were ſtopped, and the rain from Heaven was reſtrained. And the waters returned from off the Earth continually*, or, (as it is in the Hebrew) *going and returning*: returning back to the ſea from whence they came. *And after the end of the hundred and fifty days the waters were abated;* taking the ſame time in retiring as in flowing.

During this great convulſion the whole Earth muſt be greatly ſhaken; and the effects are ſtill to be ſeen. Some of the higheſt mountains ſeem to be left by the grounds falling round them, or to be themſelves raiſed by the labouring Earth; ſo as to be ſtill in a precipitous ſtate. Rocks every year fall from them: which ſhews that the time of this event cannot be very diſtant, and this confirms the ſacred hiſtory. Some parts that, till the deluge, lay at the bottom of the ſea, were then either raiſed, or left uncovered by the retiring waters; as appears from the ſea ſhells, and calcareous rocks, and chalky hills formed out of what was once marine ſubſtances. And when we ſee what large ſtrata of theſe are found in various countries, ſometimes intermixed with parts that ſhew no ſigns of having been ever covered by the ſea; theſe appearances ſhew that the convulſions muſt be wonderful. But all was under the guidance of our good and gracious Father. For by theſe convulſions proviſion is made for promoting the fertility of the Earth, and ſupplying a great variety of bleſſings. Lime and marble were thus ſtored up to employ the builder, and fertilize the Earth.

Such prodigious operations on one ſide of the globe would probably affect the other. The internal fire might be central. The bowels of the Earth may be the ſcene of one vaſt elaboratory, in which operations are carried on extending in their beneficial (as well as deſtructive) effects to the ſurface of the globe on every part. The Pacific Ocean might undergo a change ſimilar to that of the Atlantic. In that alſo are traces of very extenſive volcanic operations. The iſlands ſcattered throughout that vaſt ocean are plainly ſuch as have been raiſed by earthquakes; or left by countries ſinking round them. And the ſimilarity of language in very diſtant iſlands, between which there could be no communication, as they now are; and in the preſent ſtate of their navigation, ſhew plainly that they once were joined.

If in this manner the two vaſt oceans (the Atlantic and the Pacific) were produced; they may be conſidered as two great memorials of the divine Juſtice and Goodneſs: Juſtice in puniſhing the *wickedneſs* of that generation which *God ſaw was great*. Gen. 6. 5: and Goodneſs towards ſucceeding generations. For theſe oceans open a communication between the moſt diſtant regions, and are (like the heart in the body) the great ſources, that ſupply the tides, ſo important to navigation and commerce. They are therefore to all generations monuments of mercy and judgment.

DISSERTATION III.

Of the expected deſtruction and renovation of the Earth.

AS this powerful agent, the ſolar efflux, may have been employed in creating, guiding, and preſerving the Earth and its inhabitants; in cauſing the deluge by fire accumulated in its bowels, and expanded, the ſame agent may be employed in that deſtruction by fire, of which the Scriptures ſpeak plainly; and even reſtoring it again, of which, in the opinion of ſome, the ſame Scriptures give ſome intimation.

Of the deſtruction by fire St. Peter gives us this account: *By the word of God the Heavens were of old, and the Earth ſtandingout of the water and in the water*, (partly ſtanding above, and partly covered by theſea) *where by the world that then was being overflowed with water periſhed. But the Heavens and the Earth which are now, by the ſame word are kept in ſtore*

reſerved

ſerved unto fire againſt the day of judgment. The day of the Lord will come as a thief in the night, in which the Heavens ſhall paſs away with a great noiſe, and the elements ſhall melt with fervent heat, the Earth alſo and the works that are therein ſhall be burnt up.

The Apoſtle, that reveals theſe important events, proved his divine miſſion by many miracles; what he ſays therefore is confirmed by the great Seal of Heaven.

The world ſhall be deſtroyed by the ſame power that made and preſerved it, the word of God. It was once deſolated by water; but a greater deſolation will be effected by fire. *The Heavens ſhall paſs away with a great noiſe.* The ſame fire, that ſhall burn up the Earth, will cauſe the Heavens to paſs away, to vaniſh out of ſight; veiled in a covering of darkneſs. The elements (the Earth, air, and water) ſhall melt with fervent heat; diſſolved into one maſs by that all-ſubduing element of fire. *The Earth alſo and the works that are therein ſhall be burnt up.* And we may ſee a preparation for this great event in the combuſtible materials of which the Earth is compoſed; and in the partial deſolations effected by fire, at different times, and in various places.

But when the Earth is thus burnt up, what may be expected to follow? Fire has no power to annihilate, unleſs this ſhould be the will of God, and of this we have no intimation. Fire can only divide the different parts; and when all is done that fire ever did, what may be the ſtate of this globe reduced to aſhes, or vitrified?

Wherever the great maſs ſhall be, it will be ſurrounded by æther, and the efflux of this or ſome other ſun. For tho' the Sun ſhould be turned into darkneſs and paſs away, it may not be deſtroyed; nor indeed undergo any change, but that of being covered by the cloud ariſing from the burning Earth.

If the burnt maſs be ſurrounded by the ſolar efflux and the ætherial reflux, it will be moved as before. When the fire has ſpent its rage, it will of courſe become latent, or aſcend to join its origin. The reſtored temperature would be followed by a change ſimilar to that of its creation, as deſcribed by Moſes. Though at firſt *without form and void*, if God continues to ſend forth his *Spirit* (or ſolar efflux) this would diſpel the darkneſs, and it would *be light*. If by the ſolar impulſe and reſiſting medium the maſs continued to turn round itſelf; this would cauſe *day and night*. When by the ſame power the maſs of waters became partly rarefied into air, this would cauſe a ſeparation between the waters thus rarefied, and the waters ſtill continuing in their watery ſtate; divided by the *firmament*, or ſpace that ſeparated them. And if there were any hollows in the maſs, the waters that filled theſe would become *ſeas*.

Thus far a new creation might be effected by the *word of God* cauſing the Sun to exert his former influence, and by the operation of the ſame cauſe the Earth and ſea might be prepared for vegetables and animals. But for the production of theſe a higher (and intelligent) power would probably be employed, if we may judge of the future ways of the Almighty from what has been: a judgment which, from the ſtrict analogy, and uniformity in the works of God, ſeems highly reaſonable.

In the account of the creation it is ſaid, Gen. 1. 11. *Let the Earth bring forth graſs*. And v. 20. *Let the water bring forth abundantly the moving creature that hath life*. And v. 24. *Let the Earth bring forth the living creature after his kind*. But neither Earth, nor water, could be any thing more than a material cauſe. In forming an herb producing ſeed, or a ſeed producing an herb (and eſpecially in producing an animal with loco-motive powers) a wiſdom and power is viſible that muſt ultimately be referred to God. Accordingly it is ſaid, v. 21. *God created great whales.* And v. 25, *God made the beaſt of the Earth.* So we ſay of an architect that He built a pallace, or a city, without expreſſing the intelligent agents, capable of receiving and executing his commands. It might be ſo here,* and may be ſo hereafter; but this is not expreſsly revealed for wiſe reaſons.

If in this ſuppoſed renovation, it ſhould pleaſe the Almighty to people the Earth with rational creatures; capable of choice, of knowing, loving, and obeying the Creator; a ſuperior power might be exerted; ſuperior to angels and all created Beings. The language might be as at the firſt: *Let us make man in our image.* This Scripture is explained by others, which ſay of THE SON OF GOD, *All things were created by him;* and of THE HOLY SPIRIT, *He ſearcheth all things even the deep things of*

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* ‘It ſeems to me moſt probable, that ſuch things only as have ſome degree of underſtanding and will, can poſſeſs active powers.’ *Reid's Eſſays.*

‘The agent that produces the effects which we ſee muſt be endued with active powers; but he is behind the ſcene. *Ibid.*

God. If it be aſked, what ground have we to expect this renovation? From what is here ſaid, it appears probable, and a thing to be expected from what we perceive of the powers acting under the direction of the Almighty. But we have other reaſons to expect this renewal. St. Peter, after ſaying, *the elements ſhall melt with fervent heat*, immediately adds—*Nevertheleſs we, according to his promiſe, look for new Heavens and a new Earth, wherein dwelleth righteouſneſs.*

Theſe expreſſions *may* be figurative, expreſſing only a future ſtate of holineſs and happineſs. But after deſcribing a literal change of all things; it is not likely that the text ſhould ſo ſuddenly change from literal to figurative language. The *new Heavens* and *new Earth* may be theſe ſame Heavens and Earth, reſtored to a ſtate of glory equal (or ſuperior) to that which they had, before ſin entered into the world, and death by ſin.

A Heaven and Earth thus reſtored and glorious may be a ſuitable habitation for *the ſpirits of juſt men made perfect*, clothed with bodies ſpiritual, incorruptible, and glorious. *Behold I make all things new.* Rev. 21. 5. Theſe are the words of Jesus,

sus, and the work is his. For to him the Father ſaith, Heb. 1. of the firſt creation, *Thou Lord in the beginning haſt laid the foundations of the Earth; and the Heavens are the work of thy hands. They ſhall periſh, but thou remaineſt; and they all ſhall wax old as doth a garment; and as a veſture ſhalt thou fold them up, and they ſhall be changed.* All viſible created things are ſubject to decay and *change*, as a garment; to diſſolution and reſtoration: but the Son of God is the Creator; and, by becoming the Son of Man, is the Reſtorer or Redeemer.

DISSERTATION IV.

Of the analogy between creation and redemption.

BETWEEN the work of creation and preſervation on one hand, and that of redemption on the other, there ſeems to be a great analogy: as the ſacred Writers frequently borrow images from one to explain the other. *The inviſible things of God from the creation of the world are clearly ſeen.* Things viſible do not only prove the *divine Power and Godhead;* the exiſtence and glorious perfections of God: but they alſo ſerve as a mirror to repreſent the inviſible things of God. Natural things ſhew us the glory of God in the face of nature; and the Scriptures give us the *light of the knowledge of the glory of God in the face of Jeſus Chriſt*: and between theſe two repreſentations there is ſuch a correſpondence, that an attentive view of things natural and temporal, may help us to form better conceptions of things ſpiritual and eternal. And this is the proper uſe of natural philoſophy, by the creature to find out the Creator; and to obtain ſuch views of his goodneſs, and greatneſs, as may fill us with gratitude, and love, and holy fear. Without this effect philoſophy is but vain amuſement. But when things viſible correſpond to what is revealed in the Scriptures, concerning the inviſible things of God; and theſe correſpondences are traced under the guidance of the Written Word; theſe two great books (Creation and Revelation) help to explain each other.

In the natural and ſpiritual world we are led, as to the origin of all, to the ſame almighty GOD and FATHER, having all perfections in and of himſelf: who, being eſſentially LOVE, diffuſes light and life; in the diſpenſations of Nature by the Sun and other agents, in the diſpenſations of Grace by his only-begotten Son, his Spirit, and Miniſters. In both he is the ſame benevolent Author of good, to all that are diſpoſed to receive his gifts; while the evil qualities of others are by them increaſed. And, by a wiſely eſtabliſhed order of cauſes and effects, every thing is regulated in both, according to the different improvement or abuſe.

In nature the Sun is the great ſource of light. But this light may be ſhut out by them that love darkneſs rather than light. Some may be better pleaſed with glimmering lamps of their own invention, and offended with the great Luminary becauſe its brightneſs diſcovers what they wiſh to keep concealed.

So when *Jeſus Chriſt*, the Sun of Righteouſneſs, roſe upon a benighted world, he became the *Light of the world*, the *true Light which lighteth every man that cometh into the world*. But ſome were offended with this Light, rejected him in perſon, and ſcorned the word of his ſervants: but *to as many as received him, to them gave he power* (the great bleſſing) *to become the ſons of God*.

The Sun enlightens the Earth in various ways and degrees: by direct illumination, by light ſoftened and refracted by the atmoſphere, by light reflected from the Moon and planets; and perhaps light of every kind (except the light from the fixed ſtars) comes originally from this great ſource, though variouſly modified.

The Sun of Righteouſneſs ſhines on all, but all are not equally enlightened. Some

obſcure

this Light by the clouds of ſinful luſts and pleaſures. Some love darkneſs rather than light. Some obſcure it by contrivances of their own; preferring the glimmerings of their own imagination to the words of truth, though plain and certain.

II. As the Sun is the ſource of *light*, ſo is he of *heat*, and by this, the preſerver of life.

It is the property of THE LIVING GOD alone to give life, either immediately or by dependent beings capable of knowing and doing his will: but the preſervation of natural life ſeems to be chiefly by the inſtrumentality of the Sun; when it is already kindled in any individual (either originally or by natural generation) by the ſame Power that lightened up the Sun itſelf.

So CHRIST the Sun of Righteouſneſs is the fountain and preſerver of ſpiritual life. *In Him was life, and the life was the light of men.* For as *the Father hath life in himſelf, ſo hath he given to the Son to have life in himſelf.* And as he quickeneth *them that are dead in treſpaſſes* and ſins, ſo as to be ſaid to *live in them*; ſo when they are laid in the grave, as *the Father raiſeth up the dead*

dead and quickeneth them, even ſo the Son quickeneth whom he will.

III. The light and heat of the Sun is communicated by means of his all-pervading rays, that great efflux impelling and penetrating all; guiding the whole and quickening every part.

So Jeſus, exalted to the glory which he *had with the Father before the world was*, and *having received gifts for men*, ſendeth forth his Holy Spirit, producing life and light in his people.

The Sun himſelf is at a great diſtance from us, but his rays give light to the eye, and warmth to every part, by impulſe and penetration. So when the Saviour of the world withdrew his bodily preſence, he ſent forth his Spirit to lead his people into *all truth*, neceſſary to be known; to be their *comforter* ſo effectually, that by the teaching, guidance and quickening power of the Spirit, He is conſidered as being with them himſelf. *I will not leave you comfortleſs, I will come to you.* And this he did by ſending the Spirit; who is (in a manner inconceivable by us) ſo far one with the Father and Son, that where he is preſent, the Father and the Son are preſent alſo, John 14. 23. *If a man love me he will keep my words: and my Father will love him and we will come unto him, and make our abode with him.*

IV. The Sun by his efflux reaches the whole ſyſtem and every part of it, but not with the ſame effect. On ſome a greater meaſure of effulgence is poured, on others leſs. The light and heat are uſually proportioned to each other, but the effect is varied by circumſtances. The ſame efflux that ſoftens ſome bodies, makes others more hard. Some parts are made fruitful in valuable productions; in other parts it ſublimates the venomous juices in vegetables and poiſonous animals.

Like to this are the effects of that light and life derived from the Word of God, and made effectual by the operations of his Spirit. The direct tendency of this is to produce ſpiritual life in the ſoul, by receiving the truth both in the light and love of it. And this ſpiritual life is the ſeed of that which is eternal: *This is life eternal, to know Thee the only true God, and Jeſus Chriſt whom thou haſt ſent.* But this *Spirit of Truth* ſome will *not receive.*

Some perſons ſeem furniſhed with a degree of light producing knowledge, but the light is obſcured by ſinful paſſions and vicious courſes, and then it is corrupted to the *knowledge which puffeth up.* On the contrary in ſome there is a *zeal but not according to knowledge.* Theſe, inſtead of loving the Lord with all their heart, and their neighbour as themſelves, giving way to a ſpirit of pride and ſelf-will, are carried into acts of violence towards them that differ from them; and while they perſecute, *think they do God ſervice.* This *wiſdom cometh not from above, but is earthly, ſenſual, deviliſh.* By ſuch prevalence of corruption, even their knowledge (in itſelf a heavenly gift) is perverted to be the inſtrument of evil: the Goſpel itſelf thus perverted, inſtead of a *ſavor of life unto life,* may eventually prove a *ſavor of death unto death.*

V. The Earth (and other planets) receiving the ſolar efflux (ſo as to be enlightened, guided, and their inhabitants quickened) has been deſcribed as returning an efflux of its own, By this return, and receiving continually freſh communications, life and uſefulneſs are ſuppoſed to be preſerved; and a communication kept up between different bodies, mutually affecting each other; between the Earth and the Moon, and other planets, and even with the Sun itſelf. A communion ſimilar to this is deſcribed in God's Word as exiſting between Chriſt our head, and the living members of his body. *Becauſe I live ye ſhall live alſo. It pleaſed the Father that in him ſhould all fullneſs dwell;* and *out of this fulneſs* believers *receive.* And what they receive in ſpiritual life and light, they return in acts of love and gratitude to their great Benefactor, and in mutual exchange of kind offices towards each other.

Theſe are the acts and exerciſes of that *life of God in the ſoul,* which deſerves the name of *religion.* By theſe the flame of divine love kindled in their hearts is nouriſhed, while they return the gifts of God in adoration and praiſe; and are united to each other by encreaſing bands of brotherly love. By thus letting their *light ſhine before men* in an humble, holy, uſeful life, they *glorify their Father which is in Heaven,* and edify one another.

VI. They are alſo trained for the kingdom of glory by this improvement in the kingdom of grace; for grace is the ſeed of glory and preparation for it. They only who are made *meet to be partakers of the inheritance of the ſaints in light,* have a part of that inheritance. This being an univerſal rule of the divine œconomy both in nature and grace, the natural and ſpiritual world; that every Being ſhall occupy that place and ſtation for which he is prepared. And here is a glorious diſplay of the wiſdom, and juſtice, as well as of the goodneſs of God.

In the various kinds of vegetables and animals (all invigorated by the ſame ſolar efflux) there is a viſible proportion and ſuitableneſs between that which is, and that which riſes from and ſucceeds it, at leaſt in general and to a certain degree. The ſeeds of the night-ſhade produce night-ſhade, and from the ſhoots of the hemlock ariſes hemlock. The fern and moſs, comparatively uſeleſs or barely ornamental in clothing the barren parts of creation, produce the ſame unprofitable vegetables. While the fig-tree, the olive, and the vine, corn, graſs, and other uſeful plants, each produce their own kind: and from plants improved by cultivation is generally expected an improved produce by ſeeds or young ſhoots. It is the ſame in the animal world: like produces like. *So is the reſurrection of the dead. God giveth to every ſeed his own body.*

He that, caſting down every high imagination that would diſpute againſt the Word of God as fooliſhneſs, receiving with humility and *meekneſs the engrafted word* finds it powerful to ſave his ſoul. He ſees in the Goſpel a wiſdom and benevolence worthy of God; and where things are intimated which he cannot fully comprehend; he ſays, *What I know not teach thou me.* As he knows only in part, he is content to prophecy (preach and teach) in part, waiting for a fuller revelation in God's appointed time. And what he thus humbly waits and prays for, he will ſurely attain here or hereafter, *when that which is perfect ſhall come.*

In the ſame ſpirit of humility, and conſcious of his own demerits and helpleſſneſs, he is willing to *ſubmit to God's righteouſneſs,* inſtead of *going about to eſtabliſh his own righteouſneſs.* He ſeeks forgiveneſs of ſins as a free gift: knowing that by *grace only men are ſaved through faith, not of works leſt any man ſhould boaſt.* And he that thus *humbleth himſelf ſhall be exalted,* by pardon and peace, grace and glory.

Eſpecially is there a ſtrict correſpondence between the graces of the Spirit in the heart of the godly here, and their happineſs in life eternal. *The greateſt of theſe graces is charity*, or love to God and man: and *charity never faileth*. When faith is loſt in viſion, and hope aſcertained by fruition, then the *love of God ſhed abroad in the heart by the Holy Ghoſt given unto us*, becomes the bliſs of Heaven: while a ſpirit of univerſal benevolence, meekneſs and patience, content and thankfulneſs, tune the ſoul to join in the ſong of them, who aſcribe *ſalvation to our God, and to the Lamb for ever and ever*.

On the other hand evil tempers, prevailing in the heart now, are preparatives for future miſery. Where envy and pride, anger and worldly-mindedneſs rule in man, miſery is already begun; and nothing is wanted to complete the miſery, but continuance and increaſe. Both theſe may be expected, when the day of ſalvation is ended, and the door ſhut.

With reſpect to ſenſual pleaſures, they *that live in* them are declared to be *dead while they live*; and after natural death, this ſpiritual death will remain of courſe; becauſe then the night is come when no man can work. The ſenſualiſt, deprived of all the joys for which he had a reliſh, by loſing the natural body, muſt find a wretched void and bitterneſs of ſpirit: while the trifler, whoſe life was ſpent in mere amuſement, having neglected to ſow in due ſeaſon, of courſe will want while others reap the harveſt.

For *what a man ſoweth that ſhall he alſo reap. He that* in this life *ſoweth to the fleſh, ſhall of the fleſh reap corruption, and he that ſoweth to the Spirit, ſhall of the Spirit reap life everlaſting.* Nor does every one reap what he hath ſown in kind only, but in meaſure alſo. *He that ſoweth ſparingly ſhall reap ſparingly, and he that ſoweth plenteouſly ſhall reap alſo plenteouſly.* As every veſſel in glory will be filled, they of courſe will receive moſt plenteouſly, whoſe capacities are moſt enlarged, by that holineſs without which no man ſhall ſee God; and who by abounding in holy diſpoſitions, which lead to actions of holineſs, are moſt fruitful and abundant in the work of the Lord.

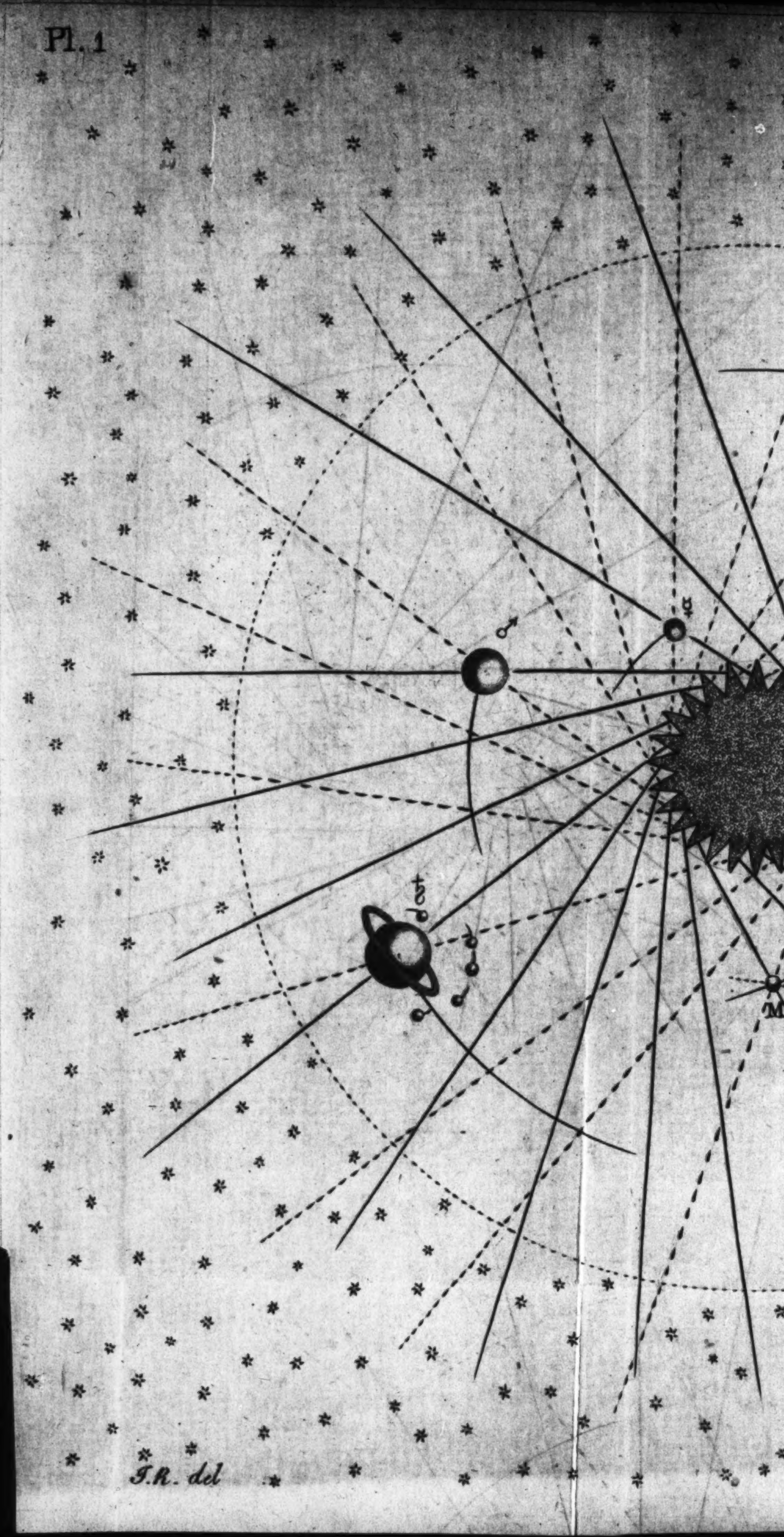
SECTION I.

Explanation of a Drawing deſigned to ſhew the ſolar efflux and ethereal reflux, as the powers by which the ſyſtem of the univerſe is moved and preſerved; being a ſummary of the preceding theory.

1. IN the centre is the Sun, which is known to turn round on its axis from Weſt to Eaſt in 25 days. This motion of the Sun is proved from the revolutions made by its ſpots.

2. Our own eyes inform us that rays of light (repreſented by the black lines) proceed from the Sun, and extend to the Earth, the planets, and probably far beyond them: by which means light, heat, and various powers are communicated to theſe orbs, and to the animals and vegetables produced in them; and the Sun itſelf made viſible among the fixed ſtars, being probably ſuns themſelves.

Pl. 1



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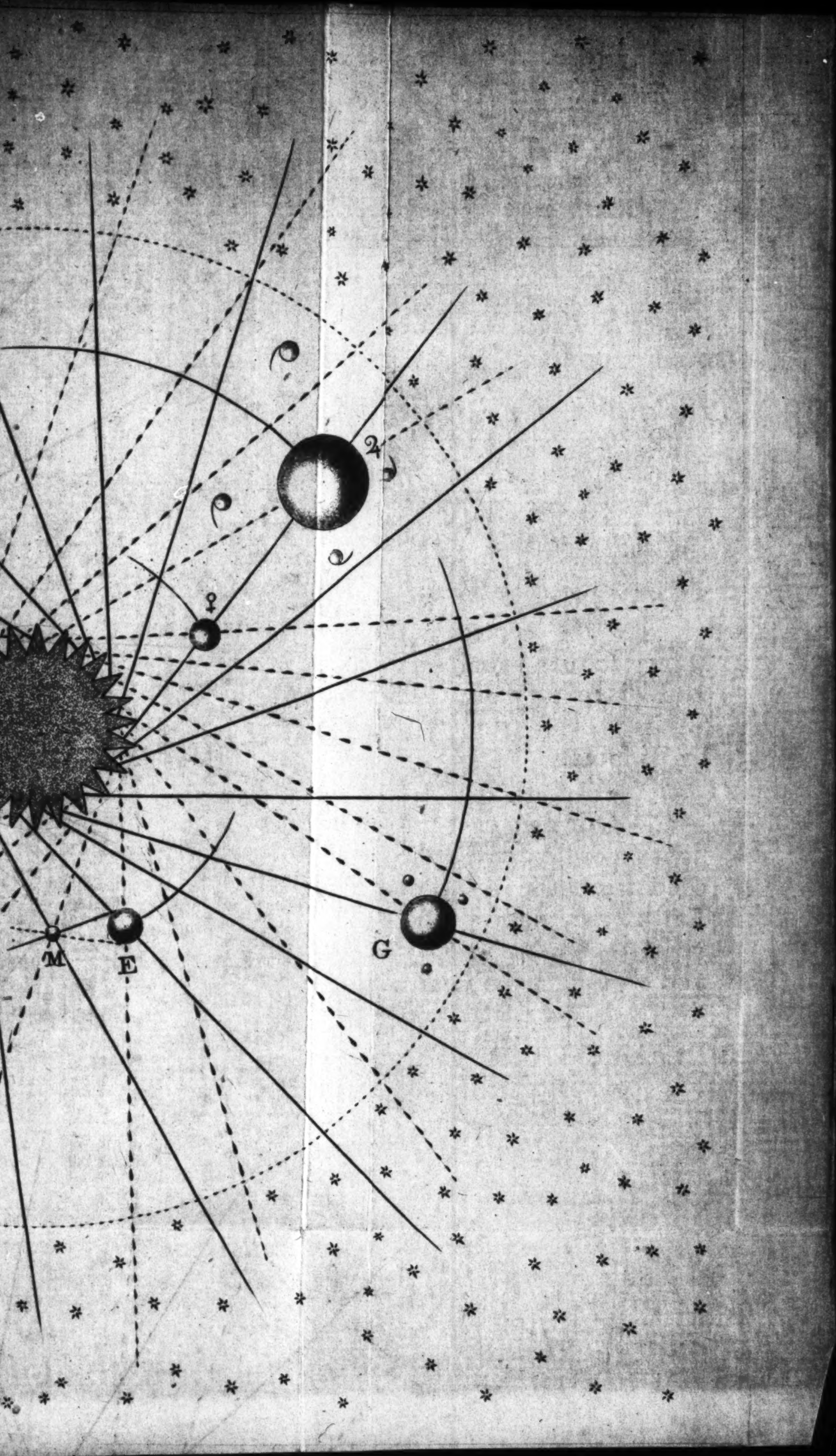
♃
♀
M
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3. As the ſolar efflux is emitted from a body moving from Weſt to Eaſt at the rate of about 3818 miles in an hour, its direction muſt be inclined towards the Eaſt. Its velocity (about 12 millions of miles in a minute between the Sun and the Earth) has been obſerved to be leſſened as it proceeds from the Sun. Which abatement is probably owing to the continual reſiſtance it meets, from the ether through which it paſſes; and this reſiſtance being continued muſt cauſe the efflux at laſt to proceed no farther.

4. In this ſtate of reſt (or gentle motion) the ſolar efflux, having gradually ſpent its light and heat, mingles with the ether, and probably becomes ether itſelf; as the hot vapour, ariſing from boiling water, mixes with, and becomes part of the atmoſphere.

5. The ether (expreſſed by the dotted lines) like all elaſtic fluids, will move towards that part where the reſiſtance is leaſt, as the wind in our atmoſphere; and this part muſt be near the Sun, by means of the vacuity cauſed by the vaſt emiſſion of the ſolar efflux.

6. In approaching the Sun, the ether is impelled towards the Eaſt by the ſolar rays inclined that way. Hence though the ether ſtill moves towards the Sun, it is in a direction* inclined eaſtward; and when it reaches the Sun, it will be in an angle ſimilar to that which is made by the ſolar rays.

7. By this conſtant influx of ether the ſolar fire may well be ſuppoſed to be fed, as common fire by the air of the atmoſphere. By this ruſhing in of ether from all parts, the body of the Sun, though it were an ocean of liquid fire, will be preſerved in its place, and in a compact ſtate. And by reaſon of the direction eaſtward, in which the ether falls into the Sun, either the Sun itſelf will be continued in its motion round its axis; or if it be the ſurface only that moves, this ſurface will be impelled eaſtward: as the waters of the Atlantic and Pacific Oceans are impelled weſtward.

8. Here then we ſee a magnificent machine manifeſting the wiſdom and power of God; eſpecially in one circumſtance which no human art can imitate. Provi-

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* The Reader will judge for himſelf between this opinion, and that propoſed at pages 23, 24.

ſion is made for its continuance in PERPETUAL MOTION.

As in the human body, the blood is ſent from the heart into every part, for the various operations of life; and that part which is ſent into the lungs receives continual refreſhment from the atmoſpherical air, (or in ſome other way) by which the powers of life are preſerved: ſo, in the grand machine of the ſolar ſyſtem, the rotatory motion of the Sun cauſes an efflux that enlightens and warms all the planets. And that part of this efflux which paſſes beyond the planetary ſyſtem, and mingles with the immenſe ethereal fluid in which the fixed ſtars ſhine, loſing its fiery nature, returns to our own (or ſome other) Sun. This return is effected by the power of elaſticity, acting like the lungs in the human body; and hereby is brought refreſhment, compactneſs, and motion to the Sun from whence it came, ſo as to perpetuate the rotatory motion of that great ſource of light. This motion and that elaſtic power are the two grand ſprings (balancing each other) by which the great machine is preſerved in all its power and beneficial operations.

9. These operations reſpect all the primary and ſecondary planets; which are kept in a compact ſtate, preſerved in their ſeveral ſtations, guided in their motions, and have their atmoſpheres, tides, and all the powers of vegetable and animal life from the combined agency of the ſolar, lunar and ſtellar efflux and ethereal reflux.

The ſolar efflux falling on a planet enlightens one half always; and the enlightened part is continually changing by the revolution of the planet round its axis, at the ſame time the planet is penetrated and impelled (in a manner elſewhere explained:) and this impulſe gives a compactneſs, or *conſiſtency*, to the whole body, and every part of it. Hence ariſes that (otherwiſe inexplicable) effect, the *gravity* of bodies. This too is the cauſe of the preſſure of the atmoſphere, and all the other appearances connected with it, uſually* aſcribed to attraction.

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* Among other effects aſcribed to attraction (and adduced to prove the reality of its exiſtence) is that of the pendulum moving ſlower near the equator, where it is at a greater diſtance from the centre of the Earth, than when near the poles, by reaſon of the formation of the Earth.

But if the nearneſs to the centre quickened the pendulum (under the pole) in its deſcent; it would equally retard it in its aſcent. Theſe two effects then deſtroying each other, the difference of vibrations can be no proof of attraction.

tion. All which effects are produced not only by the *direct* impulſe of the ſolar rays, on that half of the globe which is neareſt the Sun, but on other parts alſo by means of *refraction*.

10. But theſe effects of *conſiſtency* and *gravity* may be aſcribed not only to the ſolar efflux falling on one half of the globe, but by parity of reaſon to the ethereal reflux falling nearly on the other half at the ſame time. This has a ſimilar penetrating and impelling power, but not warming and enlightening. It may alſo be conceived to have other beneficial powers of its own; by which the planet and all its productions are refreſhed; and bearing the ſame relation to the ſolar efflux, as the *pure* and *vital* air bears to that which is ſtiled *inflammable*.

11. By the united effects of theſe two powers, the planets may be conceived alſo

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If it be aſked, Why then does the pendulum vibrate ſlower under the equator? This (if it be a fact) may be owing to the ſuperior denſity of the atmoſphere, in the equatorial regions, retarding the motion. And this ſuperior denſity may be cauſed by the ſuperior effect of efflux from the Sun, Moon, and planets moving between the tropicks. In this way the pendulum becomes an argument for the ſyſtem of impulſe. But this difference may, perhaps, be aſcribed to another cauſe. It may be the effect of heat, expanding metals, and thus lengthening the pendulum near the equator. This, of courſe will make it vibrate ſlower.

to be kept in their *ſtations* and guided in their *orbits*.

By the preſſure of the ſolar efflux every planet is prevented from coming to the Sun, and by the ethereal reflux it is kept from receding farther from him: and as theſe two powers are nicely* balanced, every orb muſt preſerve its proper diſtance.

As each of theſe powers falls on the planet in directions nearly oppoſite, but not exactly; ſo (by reaſon of the eaſtward inclination of both) ſome part on the Weſt ſide will be impelled by both, and ſome part on the Eaſt ſide will be directly impelled by neither. The effect of which muſt be to move the planet from Weſt to Eaſt, in a line concentric to that in which the Sun moves round its axis. This long experience has proved to be really the fact with reſpect to all the primary planets. The ſame principle prevails with reſpect to all the ſecondary planets, ſo far as they are affected by the primaries.

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* If it were poſſible that the force of the ethereal reflux ſhould be increaſed, this addition of ether flowing into the Sun would increaſe its activity, and of courſe the force of the ſolar efflux; till the balance was again reſtored. A ſimilar regulation would follow from a diminution of the ethereal reflux: this would proportionally abate the effuſion of ſolar rays. And it is probable that a regular increaſe and decreaſe of theſe effluent and refluent powers, depending on the diſtance from the Sun, may be the cauſe of the elliptic form of the orbits of the planets.

12. With reſpect to the *diurnal motion* of the Earth and other planets—the medium in which they move is more denſe on that ſide of the planet which is neareſt the Sun; as ſhewn in the greater thickneſs both of the black and dotted lines pl. 1 and pl. 4. This greater denſity of the radii expreſſes the greater denſity of the medium, and greater force of the momentum of both the efflux and reflux. This will cauſe a greater reſiſtance to the planet, on the ſide next the Sun; and this ſuperior reſiſtance on one ſide muſt cauſe (at leaſt continue) a correſponding motion in the planet round its axis. The part fartheſt from the Sun meeting with a leſs degree of friction, will of courſe move more freely than that which is neareſt, and produce a rotatory motion from Weſt to Eaſt.

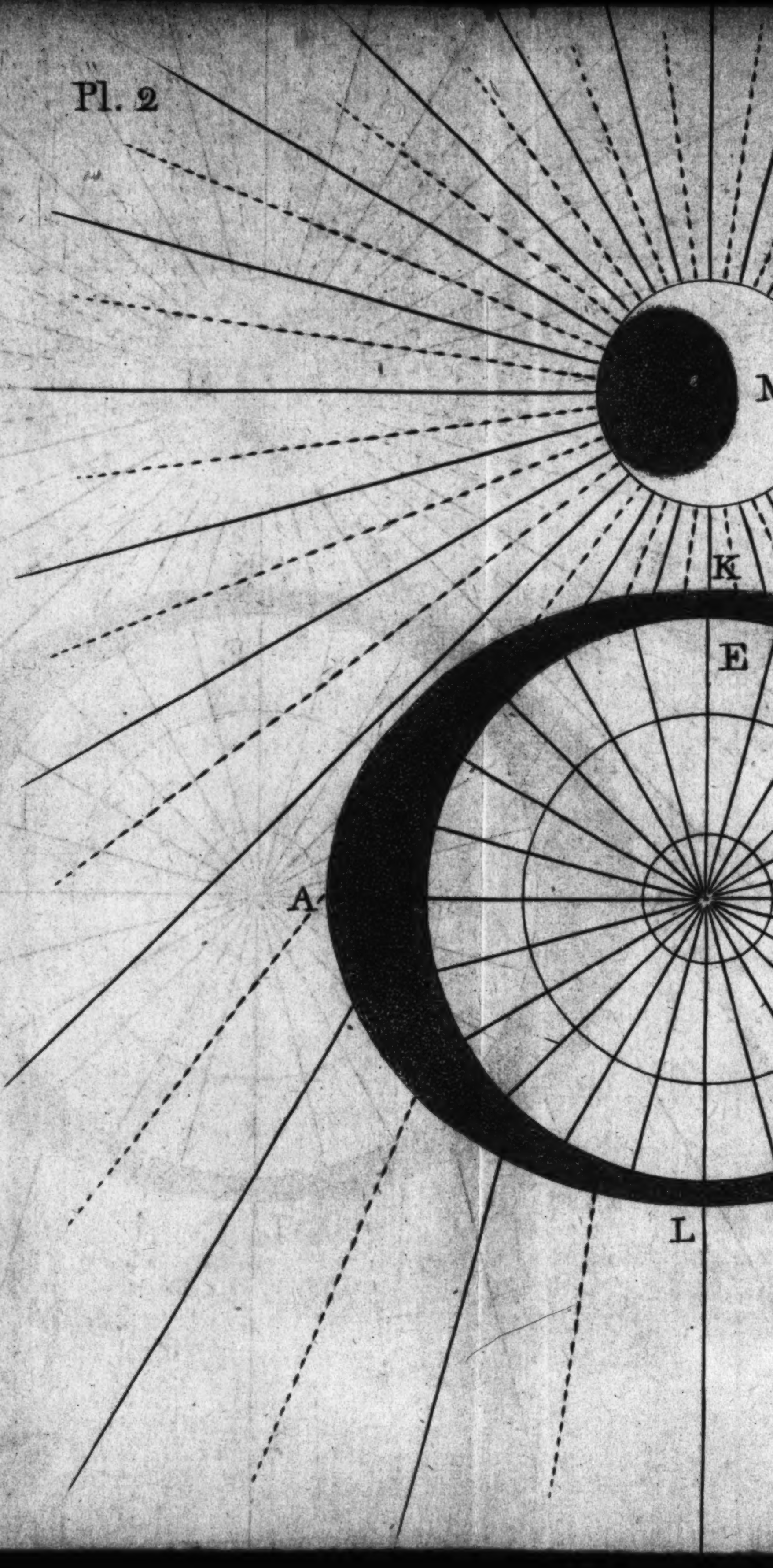
SECTION II.

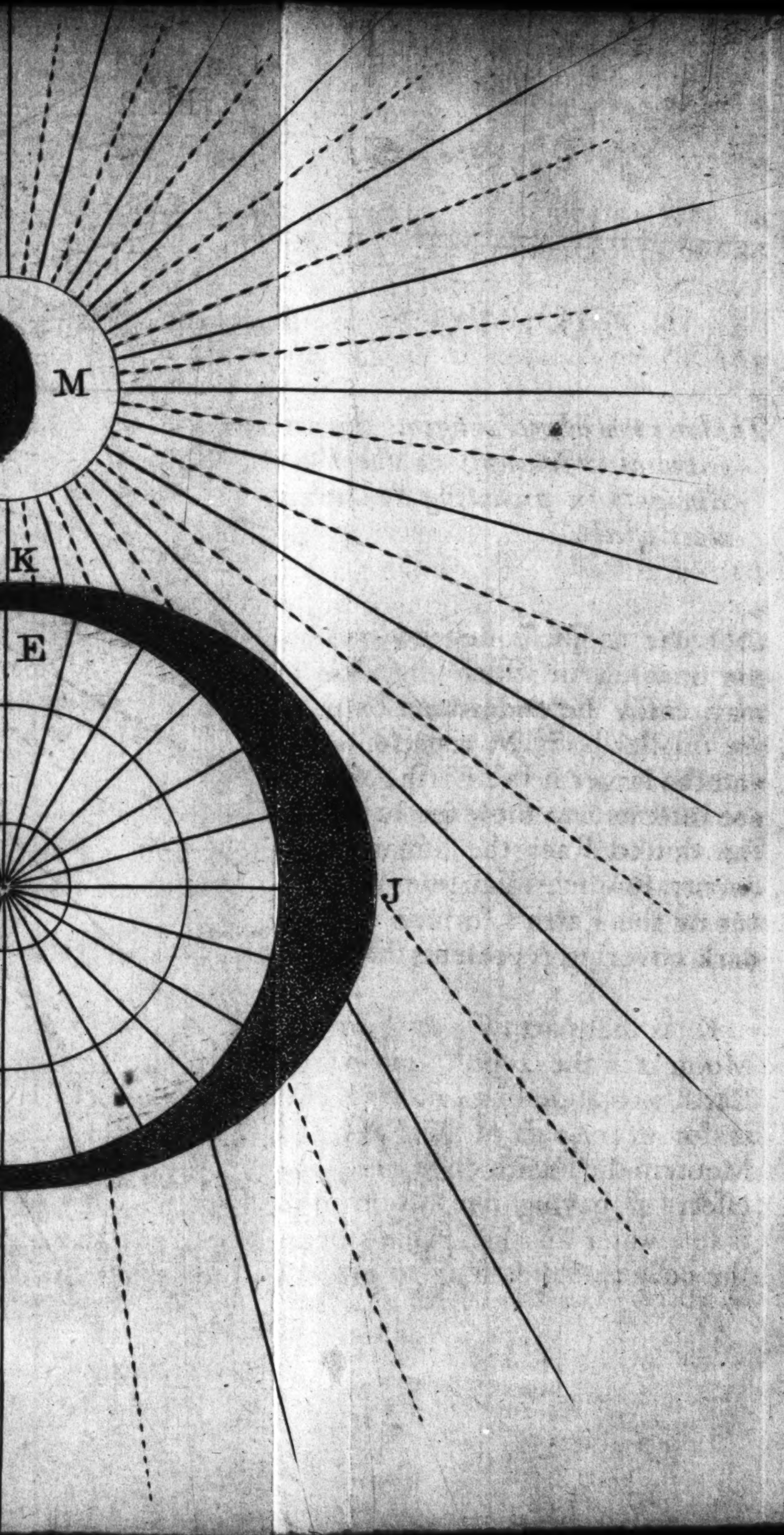
The ſame two powerful agents may well be conceived as inſtruments in the hands of the Almighty in producing the two tides, and other effects.

SO far as theſe depend on the Moon, the manner in which they are produced may eaſily be underſtood by pl. 2, where the ſmaller body M repreſents the Moon, and the larger E the Earth: the black lines are intended to ſhew the lunar efflux, and the dotted lines the lunar reflux. The twenty-four meridian lines mark equal ſpaces on the Earth's ſurface, and the uneven dark covering repreſents the ſea.

K is that part of the Earth where the Moon is in the zenith, and which by the Earth's rotation in 24 hours is changed, ſo as for every part of the Earth to have the Moon in the zenith once in 24 hours. The effect of having the Moon in the zenith is low water in that place; becauſe there the power of the efflux is greateſt to keep

Pl. 2




M
K
E
J

down the waters, as appears from the greater denſity of the lines, on this ſide, in the plate, which repreſents the lunar efflux. As the waters are kept down by this greater degree of impulſe at K, ſo as to make it low water there, they will of courſe riſe higher at A and I; ſo as to make high water in theſe parts. This accounts for one of the two tides.

In the ſame manner the lunar reflux (repreſented by the dotted lines and always equal to the efflux, being the proviſion made to prevent its diminution and deſtruction) will keep down the waters on the oppoſite ſide of the Earth at L, and produce low water there, and high water at A and I; in conjunction with the efflux at K. This may be called the ſecondary tide; and in this way two tides are produced in 24 hours by the diurnal rotation of the Earth.

What is here ſaid of the efflux and reflux of the Moon is equally applicable to the efflux and reflux of the Sun. Theſe keep down the waters in one place and cauſe them to riſe in another; but with* a

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* It may be aſked, Why is the power of the lunar impulſe greater in producing the tides than the ſolar? To this it may

leſs degree of force. And theſe two (the Moon and Sun) acting together (by conjunction or oppoſition) cauſe the ſpring tides. When they are 90 degrees diſtance the Sun leſſens the operation of the Moon, and produces the neap tide; which is proportioned to the power of the lunar impulſe above the ſolar. At other times the tides riſe or fall according as the two luminaries are near the conjunction or oppoſition, which produces the ſpring tides; or are near the quadratures, which produces the neap tides.

*In all this we need not admit any thing inconceivable as *attraction* certainly is:

but

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be replied, that the Moon is nearer than the Sun. But there is another reaſon. The ſolar efflux falls on the Earth in a direction inclined eaſtward; and the reflux is the ſame. But the lunar efflux falls on the Earth in a direct line, becauſe the Moon does not turn round its axis, except once in a ſpace of time equal to that in which it goes round the Earth.

* In this theory of the tides, the FLOOD is the direct effect of the lunar (and ſolar) impulſe on the waters made, in what may be ſtiled, the grand reſervoir; the ebb in narrow ſeas is cauſed by that impulſe being ſpent; the waters then recovering their natural level. But in the MEDITERRANEAN SEA, it may be ſaid, the fact does not correſpond with this theory, there the waters always flow from the ocean, without any appearance of retiring, as in other parts.

To account for this ſome have ſuppoſed a communication under ground, by which the waters return to the ocean. But ſuppoſing ſuch a communication under ground, this would not anſwer the end. The waters would not paſs, unleſs the level of the ocean was lower than the Mediterranean, and if this was the caſe they would not flow from the ocean into the Mediterranean.

Another way for accounting for the continual influx of waters, both from the ocean and by the numerours rivers, without any viſible return, is by EVAPORATION. The power of this ſome have endeavoured to calculate, and ſhew that it is equal to the effect. But they ſhould have taken into the account the two eddies, on the Coaſts of Africa and Spain, by which a great part of the waters ſeem to return to the ocean. In reality they do not return to the ocean, but by falling again into the current they make the quantity appear greater than it really is; as the ſame waters flow in and out ſeveral times.

Evaporation is doubtleſs equal to the effect of preſerving a balance between the two great bodies of water; for the balance is preſerved, and no other cauſe appears. But to this it has been objected that in this caſe the whole Mediterranean would in time be an heap of ſalt.

To this it may be replied that though by the evaporation ſo much of ſaline particles are not taken up as to be perceived by the taſte, yet much may be raiſed this way, made ſpecifically lighter than the atmoſphere, by their extreme diminution, and adherence to the air rarefied by the Sun. In this way the water (and ſome ſaline parts with it) may be raiſed high, and wafted over the countries that ſurround the inland ſea, and thus over (inſtead of under) the continent into the ocean. Thoſe parts of the evaporated waters that fall again on the lands, after executing the gracious purpoſes of watering the Earth, will return again into the ſea: but even of thoſe rivers a great part is evaporated again in a climate warm, and abounding in fair weather.

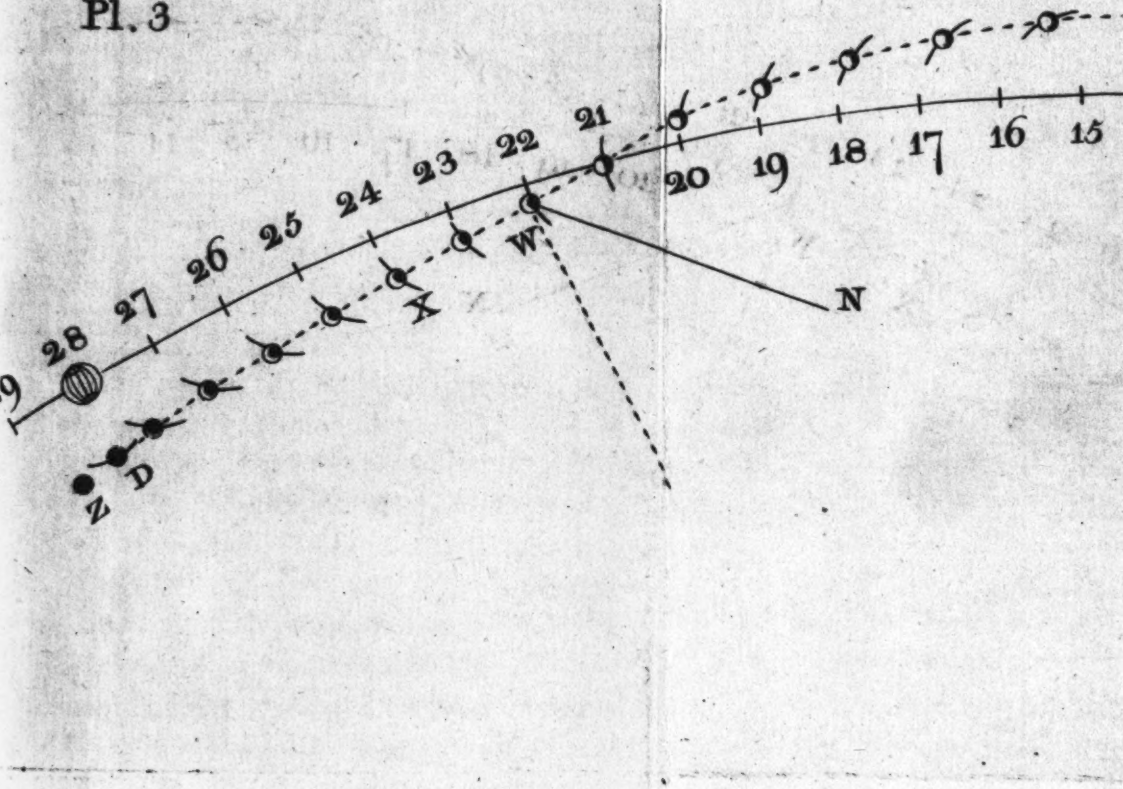
However a great part of the ſalt brought daily from the ocean is diſpoſed of in a different manner, in ſupplying the many millions of inhabitants bordering on that ſea with that indiſpenſibly requiſite article of life, of which the conſumption is very great. So that great part of the inhabitants of Europe, Aſia, and Africa (ſome even of America) are ſupplied daily with one of the neceſſaries of life which makes their other food wholeſome and palatable, by a ſtream of ſalt water, flowing in continually, from the ocean to the Mediterranean.

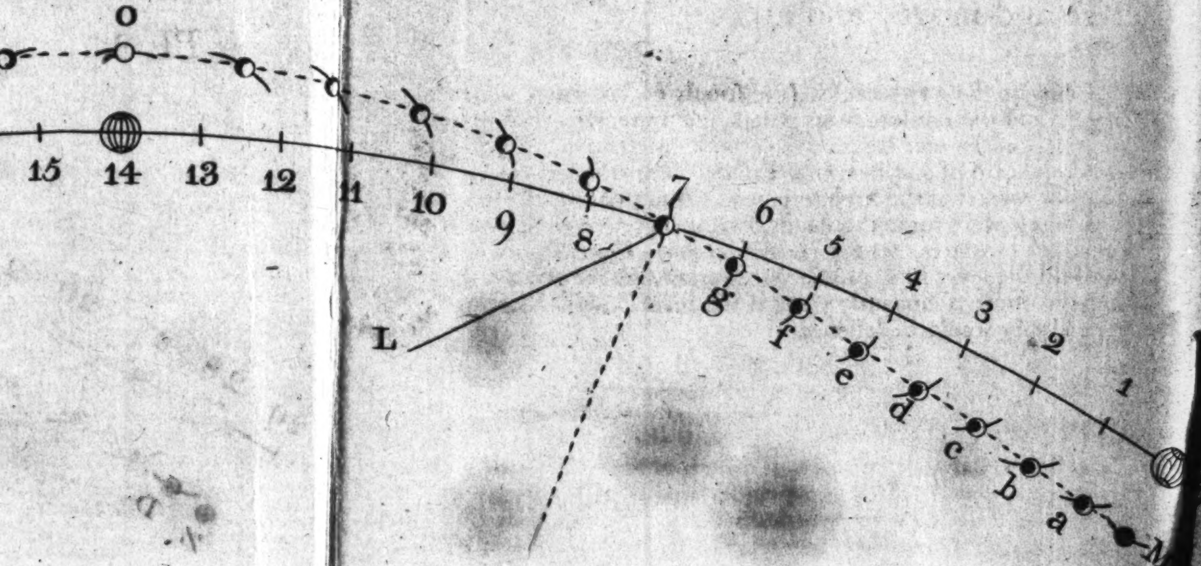
the direction of Infinite Wiſdom and Power, united to produce effects highly beneficial to mankind. For whatever agents are employed, the *Omnipreſent* and *Almighty* is ever guiding and controlling both the agents and the inſtruments; for in Him both they and we (and all that exiſts at all) live and move, and are.

Between theſe two cauſes (the ſupply of ſalt water on one hand, and the conſumption of ſalt and evaporation of water on the other) a nice balance is certainly preſerved by the providential care of our heavenly Father. For it does not appear that the waters of the Mediterranean are either ſalter or freſher than they were ſome thouſands of years ago. And as for the quantity of waters, we ſee a proviſion made for regulating that. Should the level ſink in the Mediterranean, the ocean would flow in more abundantly: and if the level ſhould riſe there, the ſupply would be leſſened.

Sec-

Pl. 3




O
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SECTION III.

An explanation of the plate repreſenting the path of the Moon; in order to prove that attraction cannot be the principle that moves it: and that its place is always where it might be expected to be, on the principle of impulſe.

IN plate 3, the line from E through 1, 2, 3, &c. to 29 repreſents ſo much of the Earth's orbit, as it paſſes through from Weſt to Eaſt during one month: and the line from M through *a*, *b*, *c*, &c. to *z* ſhews the path of the Moon during the ſame time. When the Earth is at 1, the Moon is at *a*, and is one day old. In the ſame manner, when the Earth is at 2 the Moon is at *b*. When the Earth is at 7 the Moon is at *g*, and the Moon is in its firſt quarter. When the Earth is at 14 the Moon is at *o*, and it is full Moon. When the Earth is at 21 the Moon is at *w*, and in her laſt quarter. When the Earth is at 28 the Moon is at D and the periodical lunation is completed; but it requires about two days more to bring the Moon in a direct line between the Earth and the Sun (by reaſon of the Earth's motion in its orbit) and then the ſynodical month is ended, and the Moon is new again as when it was at M.

If attraction was the principle that cauſed the motions of the Earth and Moon, when (at new Moon) the Earth is at E, and the Moon at M, the Moon then being nearer to the Sun than at any other time, the Sun's power of attraction muſt be greateſt. Of courſe* the Moon would either fall into the Sun, or continue ſtill between the Sun and the Earth. In this laſt caſe it would be always new Moon, and we ſhould forever be deprived of its light. But the fact is inconſiſtent with the principle, for, inſtead of coming nearer to the Sun, the Moon in this poſition moves farther off, and continues to do ſo fourteen days.

Again

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[*] This objection is mentioned by an eminent Aſtronomer, and anſwered thus: 'A common impulſe on any ſyſtem of 'bodies affects not their relative motions.' Here the difficulty is not anſwered, but evaded The queſtion was—Why, on the principle of gravitation, when the Sun's power over the Moon is greateſt, the effect is really the leaſt; the Moon going farther off when it ſhould come ſtill nearer? The anſwer is, that the influence is the ſame in all poſitions; which is contradictory to the doctrine of attraction being different according to the ſquares of diſtances. And if this anſwer was agreeable to truth, it would not clear the difficulty.

Again—when the Moon is 7 days old, (the Earth at 7 and the Moon at *g*) the attractions of the Sun and Earth being at right angles, the Moon ſhould move in a line ſomewhere between two lines, of which one joins her center to the Sun, the other to the Earth; that is towards L. But inſtead of this, her next movement is ſtill farther from the Sun, and without the angle formed by the lines expreſſive of the attractions of the Earth and Sun.

When the Moon is at *o* and the Earth at 14, according to the doctrine of attractions, as the Sun and Earth now act in the ſame direction, the Moon ſhould fall into the Earth, being drawn that way both by the Sun and the Earth; and both Earth and Moon would fall into the Sun; the Sun and Earth drawing the Moon, and the Sun drawing both.

When the Moon is at *w* and the Earth at 21, the Moon, in obedience to the two attractions, ſhould move towards N; but inſtead of this, without any apparent cauſe, ſhe goes on towards X.

To clear theſe difficulties, another power is called in to aſſiſt, called the *centrifugal force*.

force. But what is this? a cauſe or an effect? It is ſometimes ſpoken of as one, and ſometimes as the other: yet theſe are diſtinct things, and it cannot be both.

The planet's motion in its orbit is ſometimes illuſtrated by that of a ſtone whirled round in a ſling. The ſling is the attractive power; and the courſe of the ſtone when freed from the ſling correſponds to the centrifugal force. But tho' the circular motion of the ſtone may be conſidered as compounded of theſe two, neither of theſe, nor both are the moving power: this is the arm of him that whirls it round.

If by centrifugal force is meant not the direction of the planet, ſuppoſing it forced from attractive reſtraint; but the moving power: the next queſtion is, What is this moving power or original cauſe of motion? Whether this be the immediate hand of the Almighty, or produced by ſome ſecondary power provided by him for this purpoſe—In either caſe the motion would be in a ſtrait line, unleſs the direction ſhould be altered by ſome reſtraining or reſiſting power: and when this is done, a new impulſe ſeems neceſſary. At leaſt the effect muſt ceaſe in time, through the continual reſiſtance ; unleſs the original force be continually renewed.

But what an artiſt is he, who having made a watch, ſhould be obliged every moment to add to the power of the moving ſprings, or regulate the hand with his finger?

Not ſo the works of God ; they are all perfect, and ſhew the wiſdom as well as power of him that made them ; by adequate means provided for producing the effects intended.

If centrifugal force is defective as a *power*, what is it conſidered as a moiety of the effect, conſtituting a part of the planet's motion ?

In this reſpect the centrifugal force is ſpoken of as a motion acting in the direction of a tangent to the orbit. If by the Moon's orbit is meant its actual path through the heavens, this differs ſo little from that of the Earth, that a motion in this direction would be quite inconſiderable. It could by no means account for the Moon's courſe being at certain times not only from the Sun, and keeping the ſame diſtance from the Earth (as it always does except a trifling variation), but contrary even to the direction of this tangent.

If the tangent expreſſive of the Moon's centrifugal motion be conſidered as an appendage not to its real path, but to an ideal orbit, which it would perform round the Earth; if neither Earth nor Moon were affected in their motions by the Sun: This is ſuppoſing a caſe that never did nor can exiſt, till the Sun loſes all its power. Then the Earth and Moon will periſh with it. This ideal orbit and ideal tangent, having never had any actual exiſtence, cannot be adduced as powers, that have a real and controlling agency.

Let us next enquire whether the theory of impulſe (conſiſting of a ſolar and tellural* efflux both in an inclined direction, and a ſolar and tellural reflux equally inclined from Weſt to Eaſt) will account for the motion of the Moon, and correſpond to what is found by experience to be its place in every part of its path.

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* By tellural efflux is meant an efflux proceeding from the Earth. Some apology may be thought neceſſary for uſing a word which, I fear, is new; but no other occurs as proper to expreſs the idea.

When the Earth is at E and the Moon at M. (at new Moon) the Earth, by moving round its axis, impels the Moon in a direction contrary to that in which the Earth itſelf is moved round the Sun, and in which the Moon is alſo moved ſo far as depends on the influence of the Sun. In conſequence of this contrary direction of, what may be called, the tellural impulſe, the Moon is retarded in her courſe eaſtward, and at the end of the firſt day is left conſiderably behind the Earth. When the Earth is at 1, the Moon is advanced no farther than *a*, at the end of the ſecond day, the tellural impulſe is found ſtill to have deducted from the ſolar, but not ſo much as on the firſt day, by reaſon of the direction of the tellural impulſe being not ſo directly contrary to the ſolar impulſe as it was on the firſt day. By this ſecond day's retardation being added to the firſt, the Moon is kept ſtill farther back; and when the Earth is at 2 the Moon is only advanced to *b*.

In this manner the retardation, cauſed by the Earth's impulſe, grows leſs every day till the Moon is ſeven days old. At this time the Moon is thrown back 240,000 miles (the ſemi-diameter of her orbit. She is then at *g* when the Earth is at 7, and is retired from the Sun ſo as to be at the ſame diſtance from him as the Earth is.

In this poſition the Earth, by turning on its axis, no longer counteracts the ſolar impulſe on the Moon; but the direction of the tellural impulſe on the beginning of the eighth day, being at right angles with the ſolar impulſe, is exerted to move the Moon farther from the Sun.

As, by this motion of the Moon farther from the Sun, the line that connects the centres of the Earth and Moon is moved off more and more from the line of the Earth's orbit; the effect of the tellural impulſe will be, not only to move the Moon farther from the Sun, but to incline the Moon towards the Eaſt. This eaſtward inclination of the Moon (ſo far as depends on the Earth's impulſe) is increaſed every day, and the daily removal from the Sun decreaſes in the ſame proportion, till the Moon is advanced to *o*, and the Earth to 14. The Moon has then overtaken the Earth, by the tellural impulſe concuring with the ſolar during the ſecond quarter, and it is full Moon.

In this poſition* the ſolar and tellural impulſe act together. By this means the Moon is moved rapidly towards the Eaſt; ſo that at the end of ſeven days more ſhe is advanced as far before the Earth, as ſhe was left behind when in her firſt quarter at g. At the ſame time the Earth's impulſe brings her nearer the Sun; ſo as to have completed three parts of her orbit round the Earth. She is then in her laſt quarter at *w*, and the Earth at 21; this being then the number expreſſing the Moon's age.

In this poſition the Moon is brought nearer to the Sun for ſeven days, by the ſame power of tellural impulſe; at firſt more rapidly, afterwards more ſlowly. During the ſame time ſhe is retarded in her courſe eaſtward, at firſt more gently, afterwards more ſtrongly, till ſhe is brought to D, and the Earth at 28. The periodical lunation is then completed, and in two days more the ſynodical; when the Moon is again new: the ſame as when the Earth was at E and the Moon at M.

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* As the ſolar impulſe on both the Earth and the Moon is expreſſed by the line of the Earth's orbit, and continues in this circular direction throughout the year; ſo the tellural impulſe is expreſſed by a line drawn acroſs the Moon's centre, (as ſhewn in the figure) and is an arc of a circle of which the Earth is the centre, and a line drawn from the centre of the Earth to that of the Moon is the radius.

retired from the Sun ſo as to be at the ſame diſtance from him as the Earth is.

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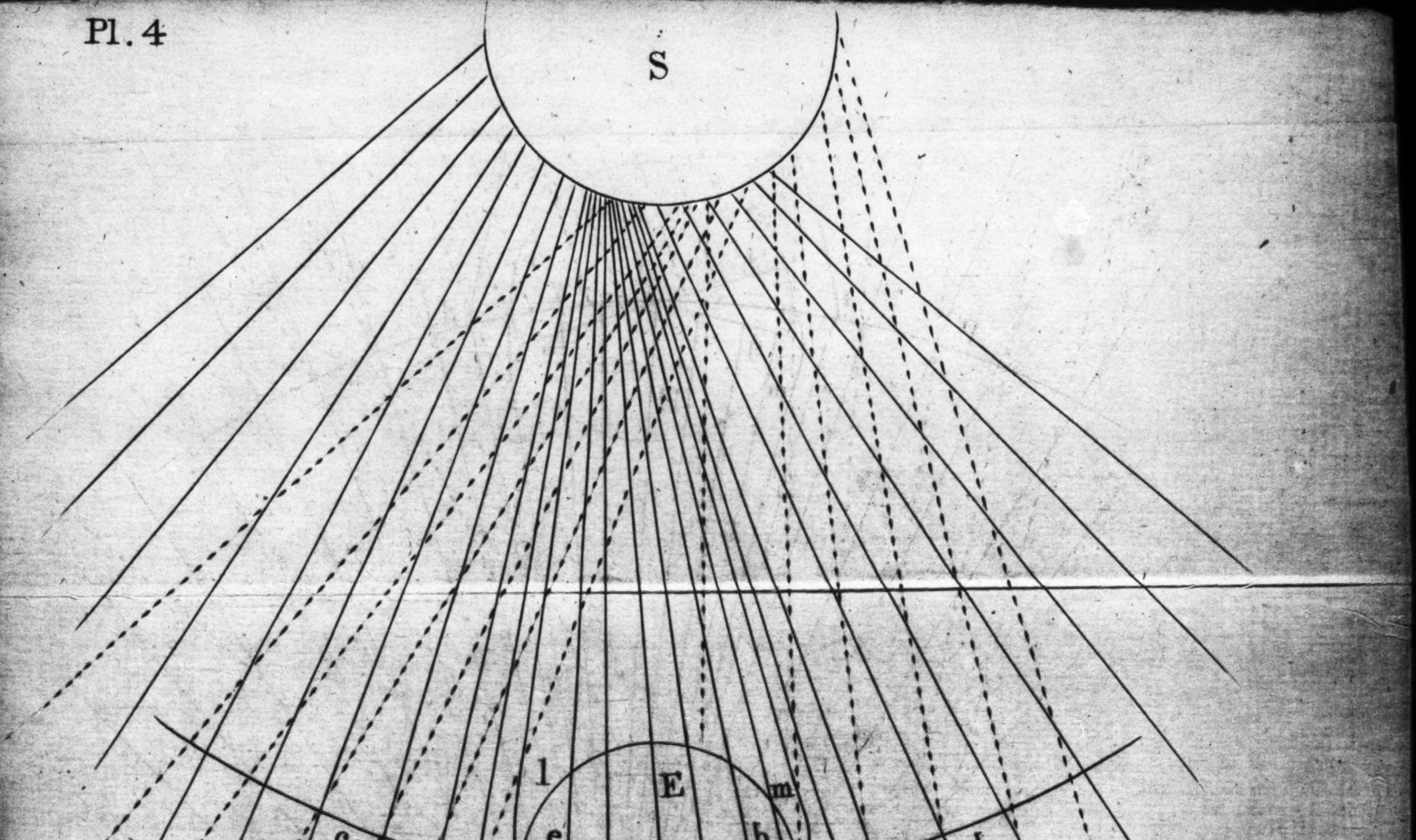
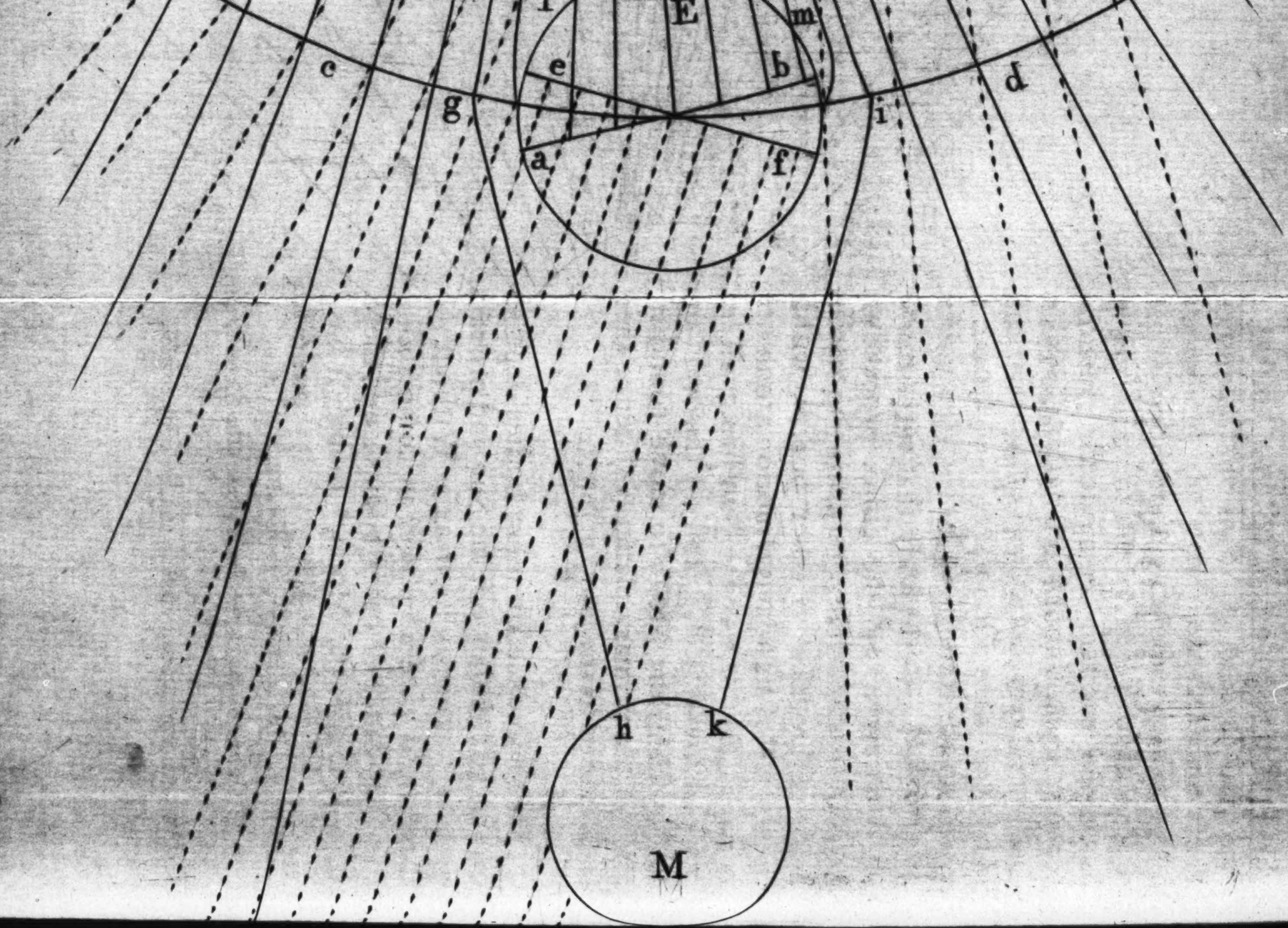
In this way the Moon's place is plainly accounted for in every part of her path throughout the year; except ſome ſmall deviation depending on other cauſes. And by purſuing this theory, it is probable thoſe eminent Aſtronomers, that are employed in inveſtigating the Moon's place, for the improvement of navigation, may be aſſiſted, ſo as to tread in a ſcientific path, inſtead of reſting only on obſervations made on many lunations compared together. A ſcientific principle aſſiſting experience collected from facts, is likely to ſucceed better than either of them ſeparately.

[illegible] of the M[illegible]
adhesion [illegible] parts
[illegible] exceed. I should
be [illegible] other particles
by [illegible] to prove
[illegible] Astronomers, that are
investigating [illegible]
improvement of the [illegible]
concerned in a [illegible]
that only would [illegible]
[illegible] compared to [illegible]
the prevailing experience [illegible]
[illegible] is likely to [illegible]
of them separately.

Pl. 4




E
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SECTION IV.

Of the inclined direction of the ſolar and tellural efflux and reflux.

EVERY heavenly body that turns round its own axis is by the efflux proceeding from it, and the reflux returning to it qualified to produce in other bodies, within the ſphere of its activity, motion around its centre. In this way the Sun brings all the planets round itſelf: and in this way the Earth cauſes the Moon to move round it; and all the primary planets influence their ſecondaries in the ſame manner.

This influence on other bodies depends on this circumſtance of the Sun and primary planets moving on their axis. Without this they could have no power in commanding the attendance of other bodies: and therefore it is that the Moon,* though it has a powerful

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* It is often ſaid that as the Earth attracts the Moon ſo the Moon attracts the Earth.

If by attraction is meant drawing another body to itſelf; in powerful efflux, does not at all influence the motion of the Earth.

This important effect of the Sun's motion round itſelf may be ſeen by inſpecting the figure No. 1, where the ray that repreſents

this way neither of them attracts. But if by attraction is meant influencing another in its orbit; though the Earth thus affects the Moon, the Moon cannot thus impel the Earth: becauſe her efflux, though very powerful, falling on the Earth in a perpendicular direction, cannot affect the Earth's motion. The Moon's efflux may keep the Earth at a diſtance, keep down the waters, and produce many other important effects; but does not help or hinder its motion, for want of an inclined direction.

If any perſon does not perceive this difference he may help his conception in the following way.

Let him place a round table in the middle of a room, with ſome moveable things on it. Let him then extend his arms in oppoſite directions, and turn himſelf round ſo as to touch with his fingers, every time, the things on the table. Every turn he makes, the things within his reach may be moved by him. This may repreſent the manner in which the Sun moves the planets, and the primary planets move their ſatellites, by turning round themſelves.

If, inſtead of turning round, the perſon keeps his face always towards the table, and in this poſition moves round the table, he will not move any thing on it; though his arms continue extended. This will repreſent the Moon's motion round the Earth; and the no-effect produced by its efflux on the Earth's motion. If the perſon walks round the table in 28 ſteps (his face ſtill towards it) he will find that in going round the table he has really turned once round himſelf. In the ſame manner the time of the Moon's orbit correſponding exactly to the time of its motion round its axis (in 28 days)—the ſame ſide of the Moon is always preſented to the Earth, as the perſon's face is to the table. By this wiſe regulation the Moon gives no diſturbance to the Earth in its diurnal or annual courſe.

repreſents the efflux, in conſequence of the Sun's rotatory motion, falls on the Earth and other planets in an inclined direction. The correſponding ray, diſtinguiſhed by a dotted line, repreſenting the reflux, falls in a direction equally inclined eaſtward. In this direction therefore the planet muſt be moved.

This is ſhewn more fully in pl. 4, where the black lines ſhew the efflux falling on the planet in a direction inclined eaſtward; of which efflux the line *a b* is the boundary: for beyond this line no part of the efflux falls on the planet. The dotted line ſhews the reflux equally inclined the ſame way, of which the line *e f* is the boundary. On the weſtern ſide, between *a* and *e* the planet is impelled by both powers. On the Eaſt ſide, between *b* and *f* it is impelled by neither. It is eaſy to ſee which way a body, thus impelled, muſt move; namely from Weſt to Eaſt, in the direction of the line *c d*. But the ſolar efflux keeps it from coming much nearer to the Sun; and the reflux prevents it from going much farther off. The planet therefore muſt go round the Sun, either in a circle or an ellipſis.

In this ſame figure pl. 4, the ray *S g h* when it reaches the atmoſphere at g, and the ray $S\ i\ k$ when it reaches the atmoſphere at i are refracted, ſo as to fall on the Moon (M) at h and k. By theſe refracted rays it is that the Moon is viſible when totally eclipſed. Theſe ſolar rays are refracted ſo as to fall on the Moon when in the Earth's ſhadow; and from the Moon are reflected to the inhabitants of the Earth: by which means we ſee the Moon of a deep red colour.

Two other rays l and m being neareſt to the Earth are ſo refracted as to fall on it. By theſe refracted rays the parts of the Earth beyond the enlightened hemiſphere are in ſome meaſure enlightened, and enjoy the benefit of twilight. In this way too the other beneficial effects, of rays deſcending from all the heavenly bodies, may be conceived to be extended, in various degrees, to thoſe parts which are not directly expoſed to their impulſe.

What is here ſaid of the Sun with reſpect to the planets, primary and ſecondary, is equally applicable to the Earth, and the other primary planets with reſpect to their ſatellites. All theſe have an efflux; and, if they all move round their axis (as certainly they do) this efflux muſt be inclined eaſtward. An efflux muſt be attended with a correſponding reflux, otherwiſe the body muſt ſoon be exhauſted and periſh. And this reflux, meeting with the efflux in an inclined direction, will of courſe be inclined the ſame way. On this principle, we have ſeen, our Moon is moved, by its occupying the ſame place, and being retarded or accelerated, as might be expected from the theory. From the univerſal harmony in the works of God it is reaſonable to ſuppoſe that all the ſatellites are moved on the ſame principle. They are turned round their primaries by the rotatory motion of theſe primaries; but cannot have any rotatory motions themſelves: (with reſpect to their primaries) this would be not only uſeleſs, but would cauſe a confuſion, no where ſeen in the works of God.

This ſame principle of impulſe, which we have conſidered as cauſing and accounting for the path of the Moon, has probably the ſame effect on all the ſatellites.

Theſe will be governed by the Sun and their reſpective primaries, as the Moon is by the Sun and the Earth. They will alſo ſend off to their primaries an efflux proportioned to the quantity of matter in each of them. In conſequence of this the largeſt ſatellites would be at the greateſt diſtance from the primary planet; provided they were all of equal denſity. They keep off the primary, and are kept off by the primary, by their mutual efflux: and in the ſame way they are kept at a proper diſtance from one another.

The ether alſo may be conceived to act on them (as on the Earth and Moon) both as a reſiſting medium, and a refluent fluid; preſſing to ſupply the vacuity made in every one by the continual efflux. By the force of efflux increaſing near the body every thing is kept off: but this repelling power decreaſes as the diſtance increaſes; and by the reflux every body is prevented from going farther than its appointed ſtation.

Thus far was written before Mr. Herſchell had publiſhed his diſcovery that the fifth ſatellite of Saturn had a motion round its axis, in the ſame ſpace of time as it moves round its primary. This correſpondence of fact, with the theory here ſuppoſed, between the primary planets and their ſecondaries, is a ſtrong proof that the theory is well founded. As the motion of the Moon would diſturb that of the Earth if ſhe moved round her axis (except in the ſame time as ſhe moves round her primary) ſo, for the ſame reaſon, it was to be preſumed, that every ſatellite would have the ſame motion, round its primary and round itſelf, in the ſame ſpace of time. By this proviſion they do not interrupt the motion either of the primary planet, or of the other ſatellites; as otherwiſe they muſt have done.

To this ſyſtem of Coſmology the objections that are ſtill made are ſuch as ariſe from doubting the reality of the *momentum*, aſcribed to the ſolar rays; and of the *change*, they are ſaid to undergo, when ſwallowed up in the regions of ether.

For an anſwer to the firſt of theſe objections the Reader is referred to the note in p. 89. By what is there ſaid, and in ſome other paſſages, it appears that the ſolar rays may not only be *ſeen*, but *felt* on the ſcorched ſkin and dazzled eye. They may be *ſeparated* and arranged under ſeven different colours. They may be *condenſed* in various degrees; ſo as to be irreſiſtible in their effect. They can *harden* and *ſoften* different bodies. They *promote* (and in ſome circumſtances *deſtroy* animal and vegetable life. They move light bodies; and cauſe a ſpring to *tremble.* Endued with ſuch properties they muſt be body, or matter of ſome kind; and being known to have a great degree of velocity, of courſe they muſt have a momentum: for this depends on the quantity of matter and motion.

With reſpect to the objections relating to the ether—if the expreſſion *changed* is diſliked, another may be uſed in its place. Say that the ſolar rays are *merged* in the boundleſs regions of ether, as a river that flows into the ocean, or hot vapor mingling with the atmoſphere, ſo as to become to all appearance part of it.

This is ſo highly probable, that we cannot ſee how it can be otherwiſe. The rays are ſent forth from the Sun with great velocity; but meeting with continual reſiſtance, as they paſs through the regions of ether, their ſpeed muſt grow leſs, and be totally deſtroyed at laſt; as a cannon ball beat by the air through which it paſſes. At the ſame time by their continually diverging they become more *rare,* till they are too few to cauſe viſion, or be luminous. And with reſpect to heat, by paſſing through colder regions their heat muſt continually leſſen. When thus deprived of light, heat, and velocity, their diſtinguiſhing properties are loſt. If they are not *changed* into ether, they are *mixed* with it ſo as to become no more diſtinguiſhable. And if the word *changed* is here uſed, there are experiments that juſtify the expreſſion; ſuppoſing ether to be ſimilar to vital air. For it is well known that the ſolar rays falling on green vegetables produce vital air, in proportion to the ſolar heat. And Dr. Ingenhouz found that vegetables by day (when the ſolar rays fall on them) produce vital air, and by night mephitic air. Theſe experiments ſhew a cloſe alliance between the ſolar rays and vital air. And this laſt is underſtood nearly to reſemble the pure ethereal fluid.

Some experiments make it probable that cold is not merely a privation of heat, but is the effect of ether penetrating even through glaſs. This is proved from the increaſe of bulk in freezing liquids. As light (the ſolar efflux) penetrates where air cannot, ſo ether (the reflux) may be equally piercing and powerful, as ſhewn in breaking the hardeſt bodies in freezing. And this confirms the theory that ether is fire deprived of its light and heat the ſame body in different circumſtances.

A ſenſible and learned Man (*Pike*, in his *Philoſophia Sacra*) aſſerts that even *darkneſs* is not a mere privation of light, but as much the effect of a poſitive cauſe as light. This opinion (which he endeavours to prove from Scripture) may not be ſo abſurd as it appears at firſt. For if the ſolar efflux and reflux continually embrace the Earth, wrapped up between them, (except a ſmall part on the Eaſt part) and thus carried as in arms through the expanſe, or heavens.—When, as in the night, the efflux is hindered from illuminating that part of the Earth's ſurface, which is turned from the Sun; the ether then only has free acceſs, and, being deſtitute of light and heat, may be conſidered as cauſing darkneſs.

Both theſe in every ſituation of the Earth retain their penetrating and impelling powers; for the circumſtances of being luminous and warm or otherwiſe, make no difference here. And therefore every proof produced of penetrating and impelling powers in one of theſe is equally applicable to the other.

To what has been ſaid of the impelling power of the efflux, may be added the following experiment.

If a ſpiral paſteboard be ſupported over a candle or lamp on the point of a needle, in ſuch a manner as to cauſe the iſſuing rays, or ſmoke, or air impelled by them (both of which are the continuation of the motion cauſed by the rays) to fall on the paſteboard in a direction ſimilar to that of the wind falling on the vanes of a windmill; the effect is a continual circular motion of the ſpiral paſteboard. A ſimilar effect is produced by two lamps, at the two ends of a lever ſupported by a ſimilar needle, with an inclined vane for the iſſuing rays to ſtrike on, ſo as to cauſe the lamps to move in a circle. Each of theſe experiments produce a *perpetual motion*, like that of the planet impelled by the ſolar efflux and reflux.

But in theſe experiments the materials are ſpent, and in this way the motion in *fact* is not perpetual, though it be ſo in *principle*. Not ſo the works of God—His ſtores are inexhauſtible, nay (as far as appears to us) undiminiſhed. With him change produces no deſtruction nor diminution:

minution: hence proceeds an unceaſing rotation of cauſes and effects.

That theſe effects are produced by the real mechanical impulſe of the rays emitted from the flame is made ſtill more probable from thoſe experiments in calcination (even in veſſels hermetically ſealed) by which it appears that the calx increaſes conſiderably in weight. If fire can increaſe weight it certainly has a momentum in impulſe. And if this is the caſe in the fire that is on Earth, there is no reaſon to ſuppoſe it may not be the ſame with the ſolar fire; when we ſee ſuch an important end anſwered by it.

It farther appears from ſome of theſe experiments that what went into the metal as *fire* comes out of it again as *air*; and that theſe two are mutually convertible. For air is generated by the admiſſion of ſolar rays into an exhauſted receiver by means of a burning glaſs; and this air becomes fire by combuſtion.

If it be aſked, How do we know that there is any ſuch thing as ether? It may be anſwered, that we know that rays of light, in various directions, paſs through the boundleſs regions between the fixed ſtars. Here is matter and motion to a great degree, and the ſpace thus occupied, and the matter thus occupying it, mankind have agreed to call ether.

But how do we know that this ether is an elaſtic fluid, for on this circumſtance depends its power to be the grand ſpring of motion to the whole ſolar ſyſtem, and perhaps many other ſyſtems?

To this it may be replied, that all fluids are more or leſs elaſtic, ſo far at leaſt as to preſs towards that part where there is leaſt reſiſtance. And when we conſider the vaſt emiſſion of rays from the Sun, this muſt occaſion a conſtant vacuity, which the ethereal fluid alone can ſupply. Analogy teaches us to judge of what we cannot examine by attending to things of a ſimilar nature. And when we conſider the great end which this elaſticity* ſeems calculated to

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* It may be aſked, How can ELASTICITY be accounted for? How can inert matter, when forcibly reſtrained, reſtore itſelf to its former ſtate?

Not by any power innate or inherent in it; for then it would not be INERT: but by the ſame external impulſe as cauſes GRAVITY, COHESION, &c.

A piece of whale-bone lying on the table is impelled by the efflux of Sun, Moon, planets, thouſands of ſtars that we ſee, to anſwer, (the preſerving the grand machine of the univerſe in motion and perpetual vigour) it would be ſtrange to doubt of this property in ether, which philoſophers have generally agreed to aſcribe to it, and without which thoſe vaſt regions would be void of motion. Such a ſcene as this no known part of the creation exhibits, activity and motion pervading the whole, it would therefore be ſtrange to exclude theſe from the boundleſs regions of ether.

There

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and have ocular proof of their impulſe; and many millions more that Mr. Herchell never ſaw. Its ſtate of reſt is the effect of theſe united impulſes. If it be forcibly bent, another force is added, and a new poſition takes place. When this new force is removed, the former cauſes produce the ſame effect: it aſſumes its former figure. The ſame influences entering through the ſame pores, and carrying part of the atmoſphere with them act as they did before. But if the texture ſhould be altered by the force applied, the influences cannot enter as before, nor produce the ſame effect.

Thus the air (or ether) compreſſed equally on all ſides is ſtill: when the proportion of preſſure is changed, the air moves. It yields to the unequal preſſure.

The fermentation of liquors, putrefaction, and a variety of ſimilar effects may be conſidered in the ſame light. Here is no ſelf-moving power in the body; but external powers preſſing with different forces, and with more or leſs freedom into the pores, (the texture being altered by a change in heat and cold, and various other cauſes) produce that variety of motions among the parts of the body, (under the direction of Sovereign power, wiſdom, and goodneſs) which is expreſſed by fermenting, ripening, decay, and an endleſs variety of other important effects.

There is one queſtion ſtill remaining to be anſwered. Some may aſk, ' How does ' this ſyſtem of Coſmology agree with the ' accounts given in the holy Scriptures, of ' the heavens and the Earth, their crea' tion and preſervation ?'

With reſpect to the principal power in this theory it has been already obſerved, that by the *Spirit of God moving upon the face of the waters*. Gen. 1, 2. may be meant the ſolar efflux and reflux. The *darkneſs which was upon the face of the deep* is removed when *God ſaid, Let there be light.* In obedience to the Divine command the ſolar rays burſt through the thick darkneſs, *and there was light*. And again, when the Earth turned on its axis, the ether (void of light and heat) became the only acting power on that ſide of the Earth which was turned from the Sun. Thus *God divided the light from the darkneſs.*

With reſpect to the riſing and ſetting of the Sun and Moon, this is the language of the moſt enlightened philoſophers to this day. And the uſe of theſe phraſes by the writers of the holy Scripture, does not imply an aſſertion, that it is the heavenly bodies that move and not the Earth.

If with ſome critics we diſtinguiſh between the *luminary* as the cauſe, and the *light* flowing from that cauſe; and if, as is aſſerted, the words expreſſive of theſe are never confounded—here is an accuracy in the ſacred Writers ſuperior to others. Thus in Pſalm 74, 16, we read, *The day is thine, the night alſo is thine, thou haſt prepared the light and the ſun:* that is both the effect and the cauſe. And when, in the Book of Joſhua it is ſaid, *Sun, ſtand thou ſtill.* The word here uſed is not expreſſive of the body of the Sun, but its light. Of courſe neither the Sun nor the Earth might be interrupted in their operations by this command; but the effect might be a detenſion of the light for two days (inſtead of one) above that part of the Earth, by an extraordinary act of Divine power.

With reſpect to a capital circumſtance in the preſent theory, (the *inclination* of the ſolar efflux and reflux) it is ſufficient, if there is nothing to be found in the Word of God inconſiſtent with it. But the laſt mentioned Writer, explaining the meaning of an Hebrew word, ſuggeſts a circumſtance that may be applied to this purpoſe; though he makes no ſuch application himſelf. ‘There is,’ ſaith he, ‘a particular

'Hebrew word (nattah) frequently made
'uſe of concerning the heavens; which is
'generally tranſlated to *ſtretch out*: but up-
'on the moſt narrow ſearch I find that this
'word ſignifies to *lean aſide, or incline more*
'*one way than another.*'

I do not mean to prove the theory from Scripture; but ſhew that it is not contrary to Divine revelation. And this it muſt be, if it be true. *God is light*, and the *Father of lights, with whom is no variableneſs nor ſhadow of turning.* The light of Scripture, and the light obtained by conſidering the works of creation are his gift. And his gifts are all in faithfulneſs and truth: ſuitable to him who is *the ſame yeſterday, to-day, and for ever.*

THE END.

Hebrew word (nattah) frequently made uſe of concerning the heavens; which is generally tranſlated to ſtretch out: but upon the moſt narrow [illegible] I find that this word ſignifies to [illegible], or incline more to any than another.

BRITISH MUSEUM

Publiſh'd [illegible]

I do not mean to prove the theory from Scripture; but ſhew that it is not contrary to the revelation. And this it muſt be, if it be true. *God is light*, and the *Father of light, with whom is no variableneſs nor ſhadow of turning.* The light of Scripture, and the light obtained by conſidering the works of creation are his gift. And his gifts are all in faithfulneſs and truth: ſuitable to *Him who is the ſame yeſterday, to-day, and for ever.*

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